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Costs of Storing Chopped and Whole Hay[1]

By Frank H. Hamlin[2] and Fred J. Bullock[3]

THIS paper presents the results of a study made on 100 farms where the chopper method of storing hay has been in use for one or more years. The primary object of the investigation was to determine the comparative costs of storing chopped and whole hay under ordinary farm conditions. It had already been demonstrated that on large, well-managed farms hay could be chopped and blown into storage at no more cost than putting the hay up in long form. If the same thing were possible for the "average" farm, then a number of very definite advantages would logically follow.

In the first place, chopped hay requires about half the storage space required for bulk hay. The farmer who has been forced to stack part of his crop outside, thereby suffering considerable loss from weathering, can get twice as much hay under cover, assuming always that his mow floor will carry the additional weight. Second and more important, the farmer who is building or remodeling his barns need provide only half the usual space for hay storage. Other less apparent advantages of chopped hay will reveal themselves in the analysis of the hundred farms studied.

Twenty-two states are represented in the survey, and the count by states is as follows: New York (23), Pennsylvania (16), Oregon (9), Illinois (7), Michigan (6), Washington (5), California (5), Indiana (4), Connecticut (4), New Jersey (3), New Hampshire (3), Massachusetts (2), Iowa (2), Kansas (2), Louisiana (2), Wisconsin (1), Maryland (1), Maine (1), West Virginia (1), Idaho (1), Utah (1), and Mississippi (1).

The chopper method had been used, in whole or in part, from one to twelve years, the average period for the hundred farms being 2.26 years. In other words, the method was a definitely established farm practice.

The amount of hay chopped per year ranged from 8 to 410 tons, the average being 106 tons. Both large and small-scale operators are therefore represented.

The kinds of hay chopped included all common legume, grass, cereal, and mixed hays. Among the legumes were alfalfa, alsike, red clover, sweet clover, soybean, and vetch hays. The grasses included timothy, Bermuda, Johnson, marsh, prairie, and wild hays. Cereals were represented by oat, wheat, and rye hays.

The machines used for chopping were all of one commercial make. Eighty were 15-in machines, and twenty were 19-in machines. They are essentially heavily-built, blower-type choppers equipped with hay-feeding mechanisms which make possible an average rate of cutting about two and one-half times greater than that of an ordinary ensilage cutter when working on hay[4]. The choppers, without change or adjustment, also cut and elevate silage corn slightly more efficiently than conventional silo fillers of equal size. All but fourteen of the hundred farms studied were making this secondary use of their machines. Cutting straw as delivered from the threshing machine and blowing it into the barn was a third use on 39 farms. Other common uses included dry fodder shredding and feed grain elevation. On the 86 farms which did not use their machines exclusively for hay, the average chopper was used only 41.9 per cent of its total yearly operating hours for chopping hay.

For power to operate the choppers there were used 60 two-plow tractors; 21 three-plow tractors; 9 electric motors, ranging in size from 10 to 25 hp; 6 automobile engines; 2 gas engines, and 2 steam engines.

Most of the farms studied were chopping all the hay that was to be fed on the place and storing market hay in long form. This permitted rather accurate comparison of the two methods. All common types of forks, slings, and stackers were being used for storing whole hay. In 69 cases teams were used to operate this equipment. Electric motors were used in 13 cases, tractors in 9 cases, and one horse in 6 cases. The remaining three farmers used no power equipment for putting up their comparatively small lots of whole hay.

Table I shows how the two methods compared as to time and labor required to store a ton of hay.

The original data summarized in Table II were gathered as a cross check on the accuracy of the data secured for Table I, but incidentally revealed in a number of cases a rather surprising effect that the chopper method had on the efficiency of the whole harvesting operation from cured hay lying in the field to stored hay in the mow or stack.

It will be noted that, in the storing operation alone, the chopper method saved 0.82 man-hours per ton, yet Table II shows a saving of 0.087 man-hours per ton for the whole operation from field to mow. Inasmuch as the loading and hauling required were the same for both methods, it would seem impossible for the chopper to save more man-hours on the whole operation than it saved on the actual storing operation. The explanation is that on sev-

Table I. Time and Labor to Store a Ton of Hay (Storing Operation Only)

	WHOLE HAY		CHOPPED HAY	
	Range	Average	Range	Average
Number of men used.....	2 — 6	3.89	1 — 4	2.08
Minutes per ton load.....	9 — 45	20.77	6 — 30	15.17
Tons stored per hour.....	0.75—6.7	2.89	2 — 10	3.96
Man-hours per ton........		1.35		0.53

Table II. Time and Labor to Store a Ton of Hay (Whole Operation from Field to Mow)

	WHOLE HAY		CHOPPED HAY	
	Range	Average	Range	Average
Number of men used....	3 — 10	5.29	2 — 10	4.26
Tons stored per hour.....	0.75 — 6	2.34	1 — 9	3.07
Man-hours per ton		2.26		1.39

[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Albany, N. Y., October 1932.

[2]Research department, Paper Machine Company. Affil. A.S.A.E.

[3]Chief engineer, Paper Machine Company. Mem. A.S.A.E.

[4]Based on three seasons' study at 22 separate farms where ordinary ensilage cutters were used for chopping hay, H. E. Selby of the Oregon station gives an average cutting rate of 1.5 tons per hour. This study of 100 farms, where machinery designed for handling dry hay was used, indicates an average rate of 3.96 tons per hour.

eral farms the labor for the whole operation was used more efficiently when the storing operation was speeded up. In other words, the chopper method seemed to fit into the whole harvesting operation better than conventional methods and tended to make the operation continuous rather than intermittent.

How this worked out in practice is perhaps best illustrated by a specific example. On one of the farms three men do the haying. Two men are needed to operate the loader in the field. When storing hay in long form, three men are needed to operate the fork and to mow away. This means that two men must ride each load to the barn. Under the chopper method, while one man is hauling, unloading at the chopper, and returning the empty wagon, the other two men are putting on the next load in the field. In this way each member of the crew works steadily at some operation essential to getting the hay under cover.

With average man-hours per ton determined for both storing methods, it is possible to compare the per ton costs fairly accurately for a typical farm having 100 tons of hay to handle each year. This will be found in Table III.

It was, of course, impossible to gather scientifically accurate data on the keeping qualities of the chopped hay on all the 100 farms. Each farmer was, however, asked his opinion on the question, "How does chopped hay keep compared to long hay?" Fifty-two said there was no difference. Forty-six said that chopped hay kept "better" or "much better." One man said that is kept all right but heated more. And one man said, "Not so good," but qualified his statement by saying that the hay he chopped may have been put in a little greener than the hay he put up long. In the few cases where it was possible to take comparative temperature readings, the whole hay showed a tendency to reach higher peak heats than chopped hay stored under the same conditions, although the peak temperatures were less general throughout the mows.

The possibility that chopped hay, in its comparatively dense storage, is a poorer subject for spontaneous ignition than bulk hay is worth consideration in light of the report of the U. S. Department of Agriculture, that fires from this cause account for a loss of 30 million dollars a year, or 20 per cent of the total annual rural fire loss. Even if present indications reverse themselves and we eventually find that chopped hay is no less susceptible to spontaneous combustion than long hay, there is still great opportunity for minimizing loss by removing this fire hazard from the same buildings which house livestock and other valuable farm property. Because chopped hay is twice to three times as dense as whole hay, it is feasible in new construction to provide for its storage in a separate structure adjacent to a one-story, fireproof, livestock stable. Just what type of structure this should be is the subject of present investigation.

Table III. Comparative Cost of Putting Whole and Chopped Hay into Storage

Basic Data on 100 Tons per Year[5]	Whole	Chopped
(a) Approximate cost of equipment installed on farm	$80.00	$365.00
(b) Per cent of equipment cost chargeable against haying	100.00	41.91
(c) Estimated life of equipment in years	10	10
(d) Average number of men used to operate	3.89	2.08
(e) Typical power used to operate	Team	Tractor
(f) Average rate of operation in tons per hour	2.89	3.96
Estimated Comparative Cost—		
(g) Annual equipment depreciation ([a x b] ÷ c)	8.00	15.30
(h) Interest (6% of $[a + g]^2$ x b)	2.64	4.78
(i) Repairs (2% of a x b)	1.60	3.06
(j) Labor (25c per hour[6])	33.65	13.13
(k) Power (10c per horse-hour[7] and 60c per tractor-hour[8])	6.92	15.15
Total cost of storing 100 tons	$52.81	$51.42
Total cost of storing one ton	.53	.51

For safe storage in the ordinary open mow or bay, a number of experienced operators stoutly maintain that less curing is required when the hay is chopped. Although this claim is not without some supporting evidence, it must be regarded as the most pernicious sort of doctrine as far as the ordinary farmer is concerned. If he chops in his hay with less than usual curing and gets by with it once, he concludes that he can do it again. Next time he may cut his curing hours a little shorter. Gradually he eliminates his margin of safety and presently has a bona fide case of spontaneous ignition on his hands.

This happened on two of the one hundred farms. In one case, samples of the hay had been taken for moisture determination at the time of chopping. These showed moisture content running up to 50 per cent, or twice as much as would ordinarily be considered safe. On the other farm the hay had been run in while still wet from a heavy dew. Both farmers were quick to see the error of their ways, and both have continued with the chopper method.

Since 1928 the authors have investigated a number of other bona fide cases of spontaneous ignition in both long

[5]The averages for the first sixty and the first eighty farms studied were almost exactly the same as for 100 farms. It is therefore probable that including more farms in the study would not materially improve its accuracy.

[6]If labor is figured at 20 cents per hour, chopped hay will cost 3 cents a ton more than whole hay.

[7]An average of five horse labor studies by state colleges in different parts of the country indicates a cost of 15 cents per horse-hour. If this figure is used, chopped hay will cost 5 cents a ton less than whole hay.

[8]Pennsylvania State College data for 2-plow tractor belt work.

For use on the farm, chopping hay for economical storage is cheaper and easier than baling

and chopped hay. When the phenomenon occurred in whole hay, it almost invariably involved the total destruction of the barn and everything in it. In every case where chopped hay alone was involved, the loss was limited to a few tons of charred hay. Chopped hay, being denser than baled hay, does not burn readily, and hence can usually be removed without firing the barn.

In two cases chopped hay had been stored at one end of the barn and whole hay at the other. In both of these cases the fire broke out in the long hay. In another case where whole hay had been stored on top of chopped hay, it seemed highly probable from the place where fire was first observed that ignition occurred in the whole hay.

In one freak case the chopped hay had been well cured, and we were at a loss to find any cause for ignition, until we discovered water standing on the concrete floor of the cow stable adjoining the bay.

So much for keeping qualities and fire hazard. In handling and feeding chopped hay there are numerous advantages. After long hay has been put up by loader and hoist, the biggest part of the handling cost is still ahead. It is a man-sized job to remove the tangled, settled hay from storage at feeding time. A preliminary study indicates that with chopped hay from one-third to one-half the usual time for feeding can be saved. With chopped hay it is easier to judge the correct amount to feed each animal. It can be handled in the feed cart. It is harder for the cows to steal each other's hay. Of the hundred farmers who were asked to compare the ease of feeding chopped and whole hay, seventy-two said chopped hay was easier to handle. Fifteen said it was very much easier. Eight found no difference and five found it somewhat more difficult because the chopped hay had to be moved a considerable distance to be fed.

On eighty-eight of the farms studied, rough palatability tests were made. Sixty-nine farmers found that their stock chose chopped hay in preference to long hay of the same quality. Sixteen men reported no difference and three reported their stock showed preference for long hay. It should be noted that, in several instances, stock did not show preference for chopped hay when first introduced to it. In at least one case good quality chopped hay was refused in barn feeding but was eaten greedily in the barnyard. After once becoming accustomed to it, stock quite generally seem to find chopped hay more palatable than unchopped. A few individual animals on a few farms, however, have continued in their preference for whole hay.

FEEDING CHOPPED HAY INCREASED PRODUCTION

Forty-four farmers said that feeding chopped hay increased production. Nine of them had definite records to bear out their statements. The balance of those commenting on this point, twenty-one in number, said they could detect no appreciable difference.

As might be expected, a number of the farms covered by this study were confronted by the problem of unusually stony fields. This handicap to the chopper method was successfully overcome in each case by taking one or more of the following precautions:

1. Proper adjustment of side-delivery rakes so as to avoid rolling stones into the windrows.
2. Use of cylinder-rake loaders which, when properly adjusted, will leave practically all stones in the field.
3. Watchfulness on the part of the men doing the loading.
4. Unloading to an open-slat platform at the side of the chopper rather than direct to the chopper's feed table.

With regard to the comparative dustiness of whole and chopped hay, most of those who were in a position to make direct comparisons agreed that with properly-cured hay there was no appreciable difference. Under-cured chopped hay was generally believed to be less dusty because of its freedom from white mold which is one of the principle causes of dustiness in whole hay of this type. Over-cured chopped hay was inclined to be more dusty than whole hay. In this connection however, the experience of one operator may be of interest. Twenty tons of bone-dry hay, which was almost black from many wettings and long lying in the field, was run through the chopper and blown on to an open barn floor. After the fog had settled, over a ton of white dust was scooped up from around the pile and hauled away. The hay itself had brightened up considerably and was cleaned up well by the livestock to which it was fed.

The following comments regarding chopped hay were volunteered by three or more farmers and are included as of incidental interest: Less hay wasted; easier to keep mangers clean; stock do not pull hay from feeding racks and trample under foot; easier to handle in lambing sheds; less mice damage in cereal hays; beef cattle fill up quicker and then lie down; work horses eat their hay in less time; animals come through winter in better condition on less grain; dairy calves take to hay earlier in life; chopping is cheaper and easier than baling; hay can be easily weighed as fed; stock consume more hay; hay sells for more; hay that would ordinarily be refused can be fed. The one comment that practically every one volunteered was, "No more work in the hot, dusty mow at haying time!"

While this study and these scattered opinions of a hundred practical farmers may not add materially to the sum total of scientific knowledge, they may well serve to open up for more thoughtful attention the problem of handling and feeding a 73-million-acre crop which has had in the past all too little attention of any kind.

SUMMARY

Equipment. For storing whole hay there is required a team and other equipment worth $80 useful only for handling hay; for chopping and storing chopped hay, there is required a tractor and other equipment worth $365, normally used 42 per cent on hay and 58 per cent on ensilage and other crops.

Size of Crew. Averages of all recorded data show for the entire haying operation, from field to mow, an average crew of 5¼ men for whole hay and 4¼ men for chopped hay; specifically, when chopping hay with a crew of 3 men and a moderate length of haul, 2 men are constantly engaged in loading in the field and 1 man does all the hauling, unloading, and storing; when handling whole hay all 3 men must leave the field with each load in order to mow away the hay. Work in a hot mow is arduous.

Work Accomplished. For the storing operation only the results show in round numbers that with whole hay a crew of 4 men handle 3 tons per hour, while with chopped hay 2 men handle 4 tons per hour.

Costs of Storing Operation Only. With all factors considered, the average tabulated cost of the storing operation only is about 50 cents per ton by either method.

General Considerations. As cited above in the specific case of the 3-man crew, chopping would show a money saving over not chopping, and in addition it would give the great advantage of more rapid handling which would normally mean better quality hay in good weather and better ability to avoid storms in catchy weather. Two 3-man crews under favorable conditions could conceivably keep the chopper in almost constant operation. For such operation there would be required 2 hay loaders, 4 wagons, 4 teams, and 6 men.

Whole hay is bulky, requires arduous labor to mow away or to remove from the mow, varies in quality during progress of removal, cannot be mixed with feed or ensilage, offers a serious fire hazard, and does not lend itself to machine conveyance from a separate hay storage to a one-story fireproof cow stable.

Chopped hay has less than half the bulk of whole hay, is easy to mow away or to remove from the mow, may be so removed as to give a uniform quality at all times, can be readily mixed with feed or ensilage, is a less dangerous fire hazard than whole hay, and it lends itself to machine conveyance from a separate hay storage to a one-story fireproof cow stable.

A Proposed System of Erosion Control[1]

By H. D. Sexton[2] and E. G. Diseker[3]

EACH year erosion takes a heavy toll of soil fertility from the farms of the South. The loss is not confined to steep slopes where gullies are formed, but occurs also on gentle slopes in the form of sheet erosion. This erosion is often unnoticed, and as a result enormous amounts of soil are lost unless methods of control are employed. The control of erosion has a very definite relationship to the maintenance of soil fertility and to the efficient use of farm machinery. Results of erosion control experiments conducted by the agricultural engineering department of the Alabama Agricultural Experiment Station have shown that terracing alone will not control erosion during the spring and summer months while the land is occupied by cultivated crops. Although winter legumes, which are grown for soil improvement, control erosion to a large extent during the winter, these results have also shown that the losses from erosion during heavy rains, after these crops are turned under, may to a large extent nullify the effects of these crops. It is therefore obvious that some method must be evolved to assist in the control of erosion while the land is occupied by cultivated crops. Such a plan should be in accord with good farming practices, as regards both crop production and the use of labor-saving machinery.

In this paper are reported the results of some preliminary studies on the use of strip cropping for erosion control, a method of running rows to avoid an excessive number of short rows, and the use of machinery on hillside land.

PLOT EXPERIMENTS

Ten erosion plots, previously described in this journal[4], were installed at this station to be used in studying the fundamental principles involved in the control of soil erosion. Each plot is 50 by 15 ft, or 1/58 acre. These plots, which are inclosed with concrete side walls, are arranged in pairs. The first pair is level and the succeeding pairs have slopes of 5, 10, 15, and 20 per cent, respectively. At the lower end of each plot there is a concrete cistern 3 ft wide, 15 ft long, and 5 ft deep. The cisterns are arranged so that they can be cleaned and drained after the eroded material has been measured and sampled. An artificial rain apparatus is used to control the amount and rate of rainfall during experiments.

Winter Erosion. In the fall of 1930 the erosion plots were seeded to hairy vetch which made a heavy growth the following spring. Each plot was saturated on April 6 and one inch of rain was applied at a uniform rate in 8½ min. The amount of water which ran off and the amount of soil lost through erosion, from each plot, were determined. As soon as the soil was dry, the tops of the vetch were carefully removed without disturbing the soil, after which rain was applied and determinations were made as described above. When the ground had again dried, it was plowed, raked smooth, and the rain treatment and soil determination were again repeated. In the fall of 1931 all plots were seeded to Austrian winter peas, and in the spring of 1932 an experiment similar to the vetch experiment was run. The results of these experiments are shown in Table I.

These data show that vetch practically eliminated erosion on slopes up to 10 per cent. Above 10 per cent the erosion increased very materially, being 569 lb per acre on the plot having a grade of 15 per cent (slope rows) and 608 lb per acre on the plot having a grade of 20 per cent (slope rows). This, however, is small as compared with 6,733 lb per acre and 9,256 lb per acre, on the same plots, when the cover crop was removed and a similar rain applied. The Austrian winter peas were not as effective as the vetch in decreasing erosion; this was due in part to the fact that the peas were severely injured by a freeze which occurred in March 1932, and, consequently, did not make as much growth as the vetch. The tremendous saving of soil by the vetch and peas is apparent, particularly when compared to the great loss of soil from plowed ground.

Summer Erosion. Vetch or Austrian winter peas control erosion for only a part of the year; therefore, unless some means is provided to assist in the control of erosion during the period while the land is occupied by cultivated crops a large part of the fertility added by these crops will be lost. The usual method of controlling summer erosion has been based on the use of terraces of various kinds. It is true that properly constructed terraces will prevent the formation of gullies, but enormous amounts of soil are lost annually on terraced fields by sheet erosion between terraces.

The problems of sheet erosion control have been studied at Auburn (Alabama) for the last three years in connection with the erosion plots whose lengths are less than the actual distances between terraces in the field. The data presented in Table II show the losses of soil during the periods that a cultivated crop was grown on the plots for the years 1931 and 1932. These data show that the erosion was less where the rows ran across the contour than where they ran with the slope, but in either case these losses were so great as to make their control absolutely necessary in order to maintain fertility. The erosion in 1931 was considerably greater than in 1932 due to heavier rains and more frequent cultivation. The decrease in erosion on Plot 7 in 1932, as compared with Plot 5 in 1932, was due to the enormous amount of soil which was eroded from this plot in 1930 and 1931. As shown in the table (Plot 7 in 1931) the rows on this plot ran with the slope in 1931. This together with

[1]Paper presented at a meeting of the Southern Section of the American Society of Agricultural Engineers held at New Orleans, Louisiana, February 1933.

[2]Research fellow in agricultural engineering, Alabama Agricultural Experiment Station. Assoc. Mem. A.S.A.E.

[3]Assistant agricultural engineer, Alabama Agricultural Experiment Station. Assoc. Mem. A.S.A.E.

[4]Nichols, M. L. and Sexton, H. D. "A Controlled Field Method of Studying Erosion," AGRICULTURAL ENGINEERING, (Vol. 13, No. 4).

Table I. Loss of Soil Caused by a 1-in Rain Falling in 8½ Min on Various Slopes with Different Surface Conditions

Slope	0 Per cent		5 Per cent		10 Per cent		15 Per cent		20 Per cent	
	Rows run with slope	Rows run contour	Rows run with slope	Rows run contour	Rows run with slope	Rows run contour	Rows run with slope	Rows run contour	Rows run with slope	Rows run contour
	Pounds per Acre									
Land in vetch	63	94	80	65	90	82	569	268	608	284
Austrian peas	203	597	142	145	191	264	324	346	267	464
Land bare	457	190	1093	193	1515	238	6733	2393	9256	5823
Land plowed	610	623	2123	1995	2315	2427	9512	6294	19,301	19,000

Table II. Loss of Soil on the Erosion Plots from Natural Rains During the Period of Cultivation of Cotton in 1931 and 1932

Plot	Rain, inches	Slope, per cent	Direction of rows	Erosion in pounds per acre 1931	1932
1	7.36	5	With slope	11,412	
2	7.36	5	Contour	4,178	
1	6.98	5	Contour		5,559
3	7.36	10	With slope	58,580	
4	7.36	10	Contour	29,696	
3	6.98	10	Contour		10,440
5	7.36	15	With slope	88,160	
6	7.36	15	Contour	47,212	
5	6.98	15	Contour		35,090
7	7.36	20	With slope	121,046	
8	7.36	20	Contour	67,338	
7	6.98	20	Contour		28,768

a large number of artificial rain experiments (not included in table) removed a larger proportion of the surface soil than in the case of Plot 5 in 1931. This excessive washing exposed the subsoil which was somewhat compacted and, consequently, more resistant to erosion.

A large number of mechanical analyses were made to determine the composition of the eroded material. An example of these data will suffice to bring out the general relationship found. On July 19, 1931, 2.73 in of rain fell on the plots in approximately 5½ h after they had been thoroughly cultivated. The plot with a 5 per cent slope, on which the rows were run with the slope, lost 6,658 lb of soil per acre of which 3,500 lb was clay and colloid. This is more than was lost during the entire year of 1932 from the corresponding plot where the rows followed the contours. The losses, as should be expected, increased with the slope. On the plot having a grade of 20 per cent, the loss of soil was 77,000 lb per acre, and of this amount 27,000 lb was clay and colloid. These data furnish representative examples of the enormous amounts of soil lost through sheet erosion which takes place in the field between terraces and show that the losses of material carrying plant food may be more than can be supplied by a winter cover crop.

"FILTER" CROPS TO PREVENT EROSION

Since the cultivation of cotton and corn is an important part of the farm economic system, the data shown in Table II indicate a need for a system of cropping in which some means are used to supplement terraces. Based on the results obtained with winter cover crops, discussed previously, it was concluded that this should be a "filter"

Table III. Comparison of the Pounds of Soil Eroded per Acre With and Without Strips of Soy Beans Grown Between Strips of Cotton

Slope	5 per cent		10 per cent		15 per cent		20 per cent	
	Cotton alone	Strips and cotton	Cotton alone	Strips and cotton	Cotton alone	Strips and cotton	Cotton alone	Strips and cotton
Before "filter" crop was removed. Total inches of rain, 13.95	6,975	5,517	14,139	7,528	51,193	11,354	47,348	14,473
After "filter" crop was removed. Total inches of rain, 8.52	2,480	2,097	2,824	2,205	12,105	3,666	14,773	3,939

crop, or a crop that permits the water to pass but retains the soil. It is obvious, from the standpoint of the soil, that this crop should preferably be a legume because of its soil-building properties. A legume would also be better than a non-legume for stock feed should this "filter" crop be cut for hay.

To study the advantage of "filter" crops between terraces, the erosion plots were planted in alternating strips of cotton and soy beans. Since the erosion plots were built in pairs it was possible to check this system fairly accurately. One plot in each pair was planted to cotton and the other plot was planted in alternate strips 12 ft wide to cotton and soy beans. The cotton was planted in 3-ft rows, and the soy beans in 18-in rows across the slope.

The runoff and the soil eroded from each plot were determined following each rain from the time the plots were planted until the beans were cut for hay. The data for a period of approximately four months are shown in Table III.

These data show that the strips of beans reduced erosion approximately 50 per cent on the plot with a slope of 10 per cent and that the effects of this "filter" crop were very marked as the slope increased. The cotton plot having a slope of 20 per cent had less erosion than in the case of the cotton plot having a slope of 15 per cent. This was due to the absence of surface soil and was previously explained in the discussion of Table II. The erosion on the 5 per cent plot was less because it was largely by flotation of particles rather than by the hydraulic effect of rapidly moving water.

These data also show that the stubble and trash left after the beans were harvested were important factors in controlling erosion until a winter cover crop could be grown to a sufficient size to protect the surface. It was observed that a stand of winter cover crops was obtained in five days on the bean strips, whereas a stand was not obtained on the cotton strips until after a rain had fallen two weeks later. This moisture conservation, as exhibited by these bean strips, is another practical feature of strip

The control of soil erosion has a very definite relationship to the maintenance of soil fertility and to the efficient use of farm machinery. However, the results of erosion control experiments conducted by the agricultural engineering section of the Alabama Agricultural Experiment Station have shown that terracing alone will not sufficiently control erosion on cultivated land. The purpose of the authors in conducting the studies reported in the accompanying paper, is to discover means whereby erosion control can be made more effective.

farming, especially where a lack of moisture is an important factor in obtaining a stand of winter cover crops.

FIELD EXPERIMENTS

To supplement the work being done on the ten erosion plots and to make a more detailed study of the relationship of soil building and machinery, a field consisting of approximately four acres was obtained. The soil on this field varies from clay to sandy loam and has slopes varying from 5 per cent to 40 per cent. This field was taken over for experimental work because it offered an extreme example of Alabama hillside field conditions.

The same plan of planting was followed on the experimental field as in the erosion plots, except that the strips of cotton and beans were each 20 ft wide so that modern haying equipment could be used. The field was plowed and a 10-ft drill was used to plant the soy beans. A specially built, two-row planter, with independently floating opening and covering units, was used in planting the cotton.

The first step in the experimental work in this field consisted of building a complete system of terraces. The Nichols terrace[5] was used in this field because it was more easily crossed by machinery than other types of terraces. This terrace consists of a broad shallow ditch with a slight mound on the lower side.

Results of earlier experimental work also showed that where rows were run with the slope there was a minimum of slippage of two-horse implements, but that there was a maximum of erosion. On the other hand, where rows were run parallel to the contours there was a maximum of slippage and a minimum of erosion. It was decided, therefore, to strike a mean between running the rows with the slope and running them parallel to the contours. This was done by crossing the contours at various angles by straight or smoothly curved rows which ran completely across the field. Since the contours of this field were irregular, the angles at which terraces were crossed varied. On the steepest part of the hillside the angle of the strips to the contours was approximately 45 deg, but on the larger portion of the field the rows crossed at angles of from 4 to 8 deg. The effect of this system of crossing terraces in reducing slippage of machinery was very marked. The experimental field has been observed closely, and on every hand it was clearly evident that the strips of soy beans had materially reduced erosion. The rows of beans decreased the velocity of the water to such an extent that most of the soil material was deposited and the tendency toward gullying was practically eliminated. Since the strips of beans crossed the terraces, materially reducing velocity of flow, practically all soil carried from the field consisted of fine material which remained in suspension and was carried out as the terraces drained.

Since the strips were approximately 20 ft wide, the soil was only moved down the hill that distance during the season. A field 200 ft wide would theoretically require 10 years for the soil to be moved from the top to the bottom. It is, therefore, obvious that, by alternating the strips from year to year on a field of this kind, the fertility could be built up and a uniform soil condition maintained.

A great variety of crops may be satisfactorily grown on the strips. Their use would depend upon the needs of the individual farm. A dairy farmer would probably need legume hay and silage, in which case the feed strips could be planted to soy beans or cow peas in one field and sorghum could be planted in strips in another field.

The width of strips should depend upon the type of soil, topography of the field, and the size of machinery to be used. Where wide haying implements are used, it is obvious that the strips should be wide enough to allow the efficient operation of this equipment. Preliminary results indicate that strips from 12 to 18 ft wide are sufficient.

[5]Terrace designed by M. L. Nichols, agricultural engineer, Alabama Agricultural Experiment Station.

TENTATIVE CONCLUSIONS

Results of studies of erosion to date indicate:

(1) That terraces, while necessary on all steep cultivated land to prevent gullying, alone do not sufficiently control erosion.

(2) That Austrian peas or vetch will satisfactorily control erosion once they cover the ground.

(3) That the losses, from a single rain, of material carrying plant food may be more than that supplied by a winter cover crop, if the land is left unprotected during the cultivation period.

(4) That planting in strips eliminates the necessity of having all the field plowed up or loose at the same time and thus exposed to great losses of soil from summer rains.

(5) That "filter" cropping reduces sheet erosion between terraces very materially and is a necessary supplement to terraces.

(6) That certain leguminous or nitrogen-fixing crops used as "filter" crops are satisfactory in preventing erosion.

(7) That the Nichols terrace can be successfully crossed by properly designed equipment.

(8) That the increased absorption of moisture in the "filter" strips, which was caused by the "filter" crop retarding the velocity of the runoff, was sufficient to get an early stand of Austrian peas.

(9) That running rows across terraces at an angle to the hillside reduced side slippage of machinery.

(10) That machinery larger than two-horse units must be made more flexible, if it is to be successfully used on hillside land.

The Future of Moisture Conservation[1]

By Ivan D. Wood[2]

IT IS my opinion that future developments in the field of moisture conservation, so far as the agricultural engineer is concerned, will come with the further development of the terrace and of contour farming. There will come developments in machines, the use of which will prepare the soil surfaces to prevent practically all run-off and check at least some surface evaporation which costs so heavily. A machine which digs 10,000 holes per acre, each having a capacity of 3 gallons, is now in the experimental stage of development. Land worked with this machine would be capable of holding 1 inch of rainfall without loss if it fell in one minute.

Why not further development also of the machines we have at hand? Suppose behind the lister there was arranged a device to construct a dam of earth in the trench at intervals of 15 to 20 feet on level ground and 8 to 10 feet on slopes. Could not the undesirable erosion in the trench be prevented, and, with a partial attempt at contouring the rows, 2 or 3-inch rain of great intensity could all be retained? When grain stubble was removed the land could be treated with this machine, and no moisture lost by run-off until the corn planting season the following spring. The moisture would not collect in one belt as it does along a terrace, but would be evenly distributed. There is a possibility that the same principle could be applied to the furrow drill and other machines which produce a trench. A series of dams along the course of the trench at frequent intervals would certainly help prevent erosion and produce a pocket to hold water or snow.

[1]Excerpt from a paper presented at a meeting of the Land Reclamation Division of the American Society of Agricultural Engineers, Chicago, December 1931.

[2]State extension agricultural engineer, University of Nebraska. Mem. A.S.A.E.

Preservative Treatments for Silo Walls[1]

By F. C. Fenton[2]

MANY of the present masonry silos in Kansas, which have been in service for ten or more years, are in a serious condition. Progressive disintegration on the inside wall surfaces is going on and has reached the point where the life and usefulness of the silo is threatened. The inside surfaces are gradually crumbling away, a small amount coming off with each removal of silage. The concrete has been softened by some action until it has a light colored chalky appearance and is easily removed with the fingers. This action has progressed so far in certain monolithic silos that pieces of the steel reinforcing are exposed to the silage, while in the concrete stave silos the walls are becoming dangerously thin in certain places. The most serious disintegration of the walls has occurred in the portion eight to ten feet above the ground level. In hollow tile silos which were made of blocks of good quality, the mortar joints are giving way and need to be replaced. Hollow tile of poor quality are disintegrating, both on the outside and inside surfaces of the silo, and have in some cases about completed their period of usefulness.

Although the action of silage acids is commonly given as the cause of this disintegration of the concrete, the author believes that alternate freezing and thawing is equally if not more responsible. Examples have been found where that part of the silo wall which is below ground is entirely free from any damage while the wall above ground is badly corroded, indicating that the acid alone is not damaging. Good quality concrete which, as other extensive tests[3] have shown, is not seriously affected by freezing and thawing, has in many instances been free from serious damage by silage action.

The question is asked each year by scores of farmers as to what to do with their silo walls, how to treat them in order to lengthen their life. Others who are erecting new silos, want to know how to treat their walls to avoid the problem now facing those who have built before.

In studying this problem in Kansas we have tried different kinds of treatment of silo walls and are observing these in actual use. We have tried most materials that have seemed to give promise, although there are many wall treatments recommended by manufacturers which have not been tried. Many of these which we did try were suggested by the Portland Cement Association, which has been working with us in this study. Six silos have been used and are now under observation. The silo wall surfaces were divided vertically into six or eight parts and a different material placed on each strip. The silos were selected to represent as wide a variety of conditions as possible from a newly erected concrete stave to a monolithic silo 18 years of age. The older silos provided a wide variation in degree of damage since toward the top the disintegration of the concrete grows less. The first silos were treated in the fall of 1928 and some additional work has been done each year since.

A brief description of the wall treatments used and their apparent success or failure follows:

Portland Cement Washes. These have been tried for many years by farmers and other with only fair success. Before applying this wash the walls were thoroughly brushed and cleaned to remove all loose or scaly material. Creamy mixtures of cement and water were applied to the walls with a stiff brush or broom. The water used in this wash was softened with lye and alum in order to create a mixture which is easier to brush on the surface. In these washes the attempt was made to replace the old cement coating which had been removed by the silage action. In fact, the same method was used in putting on these wash coats as was used by silo manufacturers to coat the interior of the newly erected stave silos. The main trouble with this treatment is that it is difficult to make these washes adhere to the walls. In the silos which we treated, these coats have come off in one or two years and they are not considered successful. In practice, cement wash coats are seldom given a fair chance to harden in the proper manner. Silo walls are frequently hot and dry, and although the walls are wetted before the wash is applied, they dry so rapidly that a soft and crumbly condition of the wash coat is produced. The cement gun has been suggested as the solution of this problem of applying new surfaces to the silo wall. However, the cost of this equipment has prohibited its use in Kansas.

Portland Cement Wash with Iron Filings. These materials were made into a wash coat and applied in a similar manner to the plain cement wash. The effect of the iron is to create a rusty surface due to the oxidation which is supposed to increase its resistance to acid. These coatings have peeled off in a way similar to the cement washes. In general, from the indications given from our trials, this coating cannot be considered as a solution of the problem.

Tar Coatings. The use of tars or asphalts has been tried by many different agencies. The results of our trials have been more favorable than otherwise. Where a heavy coat of tar was applied, it has invariably come off with the first removal of silage. Thinner tar liquids have been applied with better success. Where several applications of a rather thin water gas tar have been applied, allowing each application to dry before applying the next coat, a beneficial coating has resulted. The walls have been made more water-tight and the deterioration of the concrete at least temporarily stopped. Just how lasting such a treatment will be can only be determined by longer use. We have been recommending this treatment to Kansas farmers because it has seemed to be the most desirable of any tried so far. The tar which has proved to be successful was purchased from the Barrett Company under the trade name of Protec-Tar, at 25 cents per gallon in 50-gallon lots. This Protec-Tar was of heavy consistency which needed to be thinned with gasoline or with the tar thinner supplied by the company.

Concrete Hardener. On new silos or those not badly etched by the acids, a clear liquid, magnesium fluosilicate dissolved in water seemed to harden the concrete and improve its resistance to silage action. The beneficial effect of this wash on old silo walls has been almost negligible. This chemical was mixed at the rate of 4 pounds per gallon of water. Its cost (1929) was 16 cents per pound in 100-pound sacks, or about 66 cents per gallon of liquid ready to apply.

Sodium Silicate (Water Glass). This has also seemed to improve the qualities of new silos, but on old silos badly etched by the silage action there has been no apparent beneficial result to the wall after two years in service.

Concrete Paint. One company claimed that concrete

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[1]Paper presented at a meeting of the Structures Division of the American Society of Agricultural Engineers, held at Chicago, November 1932. This paper is based on the investigational work being done in connection with Project 92 of the Engineering Experiment Station, Kansas State College, departments of agricultural engineering and applied mechanics cooperating.

[2]Professor of agricultural engineering, Kansas State College. Mem. A.S.A.E.

[3]W. G. Kaiser and K. I. Church, agricultural engineers of the Portland Cement Association, assisted in silo-wall treatments.

paint would successfully resist the action of silage. Accordingly on a new cement stave silo a portion of the wall was covered with concrete paint over the regular cement wash. This treatment, which included three different coats, looked very promising when completed, but after the silage had been removed for the first time the paint had nearly all scaled off.

Aluminum Foil. This can be secured in rolls convenient for applying to the inside surface of silos. After cleaning the silo walls of all loose materials and the rough surfaces are removed, the wall was covered with a black cement provided for that special use. The aluminum foil was then pressed firmly on this cement and rolled out smoothly. After one year in the silo this foil appears to stand the silage action very well. There seems to be some tendency to crawl or slip downward on the wall along with the settling silage. There also seems to be some tendency to injure the foil with the tools used to remove the silage. The cost of materials for covering the inside of a silo 16 by 40 feet with aluminum foil would be about $75.00.

Synthetic Resin (Cumar). This was applied to a silo this past fall (1932) at the suggestion of Mr. W. G. Kaiser of the Portland Cement Association. No observations have been made so far on the condition of this coating, but it gave promise at the time of application of being very valuable. It is reasonable in cost and comparatively easy to apply. Its vehicle is benzole, which carries it into the porous walls readily. If synthetic resin stands up under use it may prove to be the best material tried so far.

Liquid Rubber. Present low prices of rubber bring this material within the possibility of use for silo coatings. Rubber is a remarkable material which serves in many places under severe conditions. Liquid rubber may not be suitable for silo coatings, but laboratory tests indicate that it will adhere to concrete under severe conditions of freezing and thawing. Trials on actual silo walls will be made next season.

As indicated by the foregoing discussion, we do not know how best to treat silo walls to prevent disintegration. Some progress has been made, and it is hoped that a real answer to the problem may soon be discovered.

Silo Wall Protective Coatings[1]

By G. F. Steigerwalt[2]

THIS PAPER is not intended to cover completely the field of protective coatings for masonry silos, nor are the conclusions drawn to be accepted as a final answer to this important problem. It is confined to tests made in the research laboratory of the Portland Cement Association to check the value of different materials as protective coatings. The materials in the tests were compared with materials having known values of protection as determined from field tests. The test results together with the methods of procedure and materials are briefly described. Only those materials which indicated possibilities for further investigation and field tests are mentioned.

Series No. 1. In this series, quarter-inch staves, approximately 2½ by 7½ by 10 in, both wet-cast and dry-tamped, were used as specimens. These were coated with the materials listed in Table I, then allowed to set or cure as required. All of the materials were applied according to manufacturers' directions.

The acid solution used in the test consisted of 1 per cent acetic acid and 1 per cent lactic acid. This solution is more concentrated than that contained in ordinary corn silage. The specimens were exposed for twelve periods of 8 hours each, with a 16-hour drying period between exposures. These specimens were inspected before and after exposure. After twelve cycles were completed, the remaining solutions were analyzed for acidity, with the following results:

Table I

Coating	Per cent Acidity*
G. F. 99	85
Bay State	81
Silo-tite	77
Valdura	76
Blak-Jak	68
Black Driwall	67
Cement and 50 per cent iron filings	64
Inertol	46
Linseed oil	39
Cement and Ferritex	23
Portland cement and lye and alum	10
Plain cement wash	7

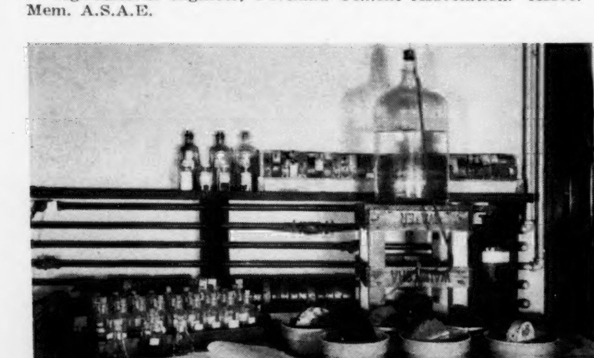
*A high percentage of acidity indicates slight attack on specimen or coating.

Practically no difference could be noted between specimens made by the wet-cast and dry-tamped method of manufacture.

Because of the difficulty of shaping concrete stave specimens to proper size with smooth edges on which to apply coatings, the specimens used in succeeding tests were changed to 1 by 4-in concrete disks. These disks

[1]Paper presented at a meeting of the Structures Division of the American Society of Agricultural Engineers held at Chicago, November 1932.

[2]Agricultural engineer, Portland Cement Association. Assoc. Mem. A.S.A.E.



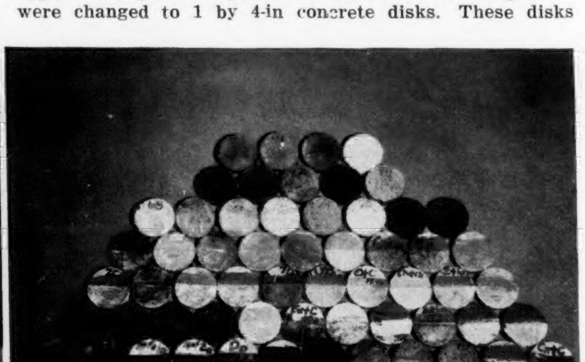


Fig 1. (Left) The laboratory set-up used in checking protective coating materials. Fig. 2. (Right) Some of the coated specimens after exposure in acid

Table II

Specimen	Physical Condition	Per cent Dissolved CaO in Solution*
Inertol (wash)	Peeled	0.285
Inertol (rough)	Good	0.034
Linseed oil (wash)	Fair	0.686
Linseed oil (rough)	Fair	0.413
G. F. 99 (wash)	Fair	0.555
G. F. 99 (rough)	Fair	0.433
Blak-Jak (wash)	Peeled	0.804
Blak-Jak (rough)	Good	0.075

*A low percentage of dissolved lime indicates slight acid attack.

were made of a 1:3 portland cement mortar, similar to stave mixes. The method of testing the remaining acid solution following exposure to specimens was also changed because of the involved laboratory procedure. Since the amount of lime dissolved in the solution is a measure of the amount of acid attack in the specimen, or coating, this method was used in the following tests:

Series No. 2. To determine the effectiveness of coating materials, to stick to either a rough or smooth-wall surface, several coatings were applied to roughened disks and to disks which had been given a smooth portland cement wash coat. After the coatings had cured or dried, specimens were placed in 700 cc of 2 per cent lactic-acetic acid solution for 48 hours. The percentage of dissolved lime in the remaining solution was determined from 50 cc samples. This percentage and physical condition of specimens are noted in Table II.

As noted from both physical condition and dissolved CaO, Inertol and Blak-Jak when applied to a roughened surface offered good resistance to acid attack. When these same materials were applied over a cement wash, they peeled and were not effective coatings.

Series No. 3. This series of disks covered with the materials listed in Table III were subjected to 48 hours exposure in 700 cc of 2 per cent lactic-acetic acid solution; 50-cc samples taken from the remaining solution gave the analysis for CaO (dissolved lime) shown in Table III.

Table III

Coating Material	Dissolved CaO in remaining solution after 48 hours exposure
G. F. 99	0.228
Linseed oil	0.219
Fish oil (blown)	0.005
Chinawood oil	0.006
Cumar, 5 lb of V3	0.178
Cumar, 5 lb of V3 plus rubber cement	0.005
Cumar, 5 lb of V3 plus 5 oz rubber (crepe)	0.031
Cumar, 5 lb of V3 plus 15% portland cement	0.039
Cumar, 5 lb of V3 plus 10 oz broken down rubber	0.011
Cumar, 6 lb of V3	0.067
Cumar, 6 lb of V3 plus 2 parts portland cement	0.065
Cumar, 6 lb FX	0.007
Cumar, 6 lb FX plus portland cement	0.039
Mulsomastic	0.020
Mulsomastic plus portland cement	0.045
Mulsomastic plus Cumar, 5 lb V3	0.002
Nataz (emulsified asphalt)	0.010
Stonite	0.003
S. D. O.	0.003
Rust-Oy	0.008
Portland cement wash check	0.546

LABORATORY TEST INDICATIONS

1. The following materials offer possibilities as coatings for silo walls: (a) portland cement plus iron filings containing sal ammoniac; (b) coal tars when applied on rough surfaces; (c) emulsified asphalts plus (1) portland cement or (2) Cumar solutions; (d) Cumar solutions (1) clear, (2) with rubber, (3) with portland cement, (4) with emulsified asphalts; (e) Stonite; and (f) S.D.O.

2. Favorable results with these materials depends on (a) clean walls, (b) complete coating, (c) proper mixtures of the materials, and (d) sufficient time and proper curing for the coatings to become set or hard.

Source of Materials Used

Iron filing No. 26—Belmont Smelting & Refining Co., 330 Belmont Avenue, Brooklyn, N. Y.
G. F. 99—Truscon Laboratories, Detroit, Michigan.
Linseed and Chinawood Oils—Paint supply dealers.
Inertol—Inertol Company, Builders Building, Chicago.
Blak-Jak—Blak-Jak Paint Products Company, Des Moines, Ia.
Stonite—Stoner-Mudge Company, Pittsburgh, Pa.
Mulsomastic—Tremco Manufacturing Company, Cleveland, O.
Nataz (emulsified asphalt)—Al-Oys, Inc., Chicago.
Cumar, V3 and FX—The Barrett Company, 40 Rector Street, New York, N. Y.
Rust-Oy—Williams Alloy Products Company, Elyria, O.
S.D.O.—E. I. duPont de Nemours & Co., Inc., Wilmington, Del.

NOTE: On account of space limitations, directions for preparing and applying the silo wall protective coverings were not included in the foregoing paper. This information, however, will be furnished to anyone interested, on request to the author —33 West Grand Avenue, Chicago, Illinois. At the time this paper was prepared, several of the better coatings were undergoing tests in canning factory silos. The results of these field trials will later be reported by the author.

The Cement Gun Method of Silo Repair[1]

By S. A. Witzel[2]

IN THIS method of silo repair, called the "gunite" method, the cement and sand are mixed dry and fed into the cement gun. There are two chambers in the machine, one being above the other, so that sand and cement may be fed into the top chamber. After the top chamber is charged a cone valve closes this chamber and compressed air is admitted. When the pressure in the top chamber equals that in the bottom chamber, a cone valve between them is opened, and the charge in the top chamber is allowed to pass into the lower chamber. The pressure is maintained in the lower chamber, while that in the upper chamber is exhausted and the charging operation is repeated.

A plate similar to that in a corn planter feeds the dry sand and cement from the lower chamber into the heavy hose. Compressed air carries the sand and cement to the nozzle where water is added. The resulting mixture is directed against the surface being coated by the nozzleman.

The equipment required for sand blasting the old walls and placing gunite includes a small cement mixer and motor or engine, cement gun with necessary hose and fittings, a 40 to 60-gal water tank tested for 125 pounds pressure, and air compressor and motor unit of sufficient capacity to operate the size gun selected, scaffold for the interior of the silo, sand blaster's uniform, and a truck for transporting the equipment. The cost of this equipment would be between $4500 and $5500.

From the cost data on the silos repaired with gunite, it was found that some required much more labor and material than did others. A contractor doing this work should have a large number of silos located fairly close together. He would have to charge for the material, and he would also have to charge for labor, profit, and rental on his equipment. The total cost would probably average between $150 to $200 for an average silo of 14 by 36 feet.

The life of the gunite-repaired silo, when properly repaired and reinforced if necessary, should be equal to that of a new silo. The coating is dense and hard, thus enabling it to resist the attacks of the acid in the silage and the effects of freezing and thawing.

[1]Part of a paper presented at a meeting of the Structures Division of the American Society of Agricultural Engineers held at Chicago, November 1932.

[2]Agricultural engineer, University of Wisconsin.

Field Curing of Hay as Influenced by Plant Physiological Reactions[1]

II. The Role of Leaves in the Dehydration of Hay Plants

By T. N. Jones[2] and L. O. Palmer[3]

FOLIAGE leaves of plants, especially of the mesophytic angiosperms, are adapted for rapid transpiration or evaporation of moisture due to their broad flat surfaces which are perforated with small pores known as stomata. The size of these pores is controlled by two specialized cells, shaped very much like bananas. These cells, known as guard cells, differ from the ordinary epidermal cells which surround them by being richer in protoplasmic material, containing chloroplasts having a different form and having a higher concentration of cell sap which changes in its osmotic value, while that of the epidermal cells remains practically constant. The inner wall of each guard cell is somewhat thicker than the outer and an increase in turgor pressure will cause them to curve outward, increasing the size of the stomatal pore, while a decrease in turgor pressure will cause a collapse and consequently a partial closing of the pore. These cells are thereby rightly called "guard cells," since they act as governors of the size of stomatal pores which are passageways for practically all of the water that escapes from the plant.

Miller[4] reports that a single corn plant growing in Kansas in 1924 transpired 54 gal of water during the season or an average of 4½ qt daily. Thus one is impressed with the rapidity of the continuous flow from the soil through the root hairs into the conducting elements and then to the leaves where it is either combined with CO_2 to form food or passes out through the stomatal pores in a gaseous state. It then seems logical to conclude that, if the normal flow of water through the vascular bundles to the stomatal chambers for evaporation could be retained without any serious check after plants are cut, the possibilities for more rapid and economical curing of forage plants would be expected. It is, therefore, the purpose of this paper to show the effect of leaves upon the removal of water after plants are cut, and the behavior of stomata during the process of curing, not as an end within itself, but rather as a fundamental explanation of results obtained in field curing of hay, and as a foundation for the scientific development of the dehydration of forage crops. However, this presentation is made as a progress report which awaits further research to justify final conclusions as to the mechanical principles involved.

Curing with Leaves Removed and Attached. There is a rather prevalent opinion, and one that has frequently found expression in agricultural literature, that forage crops cure more quickly if handled in such a way as to maintain the leaves in as fresh condition as possible until enough time has elapsed to permit the stems to lose much or most of their moisture. This view is well expressed in the following citations:

"In growing plants there is a constant stream of water entering the roots, carrying plant food through the plant to the leaves, where the water is thrown off by transpiration. When the plant is cut off, as in the case of hay plants, the leaves, if kept alive, will continue to transpire or pump the water from the plant until a large per cent of it has evaporated." McClure, H. B.—U.S.D.A. Farmers' Bulletin 943, p 6.

"As soon as the plants are cut the leaves lose water and draw on the stems for more . . . If they dry too fast . . . the leaves are killed prematurely; they stop pumping water out of the stems . . ." Pieters, U.S.D.A. Year Book, pp 285-325, 1924.

"After the plants are cut, while the leaves are wilted, but before they are too dry, the leaves draw moisture from the stems of the plant. As soon as the leaves become dry, they cease drawing moisture from the stem . . ." Waldron, L. R.—N. D. Agricultural Experiment Station Bulletin 95, 1911.

Similar statements have been published by Mohler, Carrier, Wing, Roberts, and Kinney, but U.S.D.A. Technical Bulletin No 1424 presents results which are rather contradictory in nature to all this work. The experiments recorded in this bulletin were conducted in 1925 at Redfield, South Dakota; Bard, California; Rosslyn, Virginia; and North Ridgeville, Ohio. The conclusions, however, were drawn from results of only one year's work, and samples were taken at rather lengthy intervals for a check on stomatal behavior or the pumping action of the leaves. The shortest interval between periods of sampling was 1½ h following cutting for the first sample and 7½ h for the next. In all other tests they were of still greater length, even so lengthy as to be useless when we consider that the tender mesophyll tissues of the leaf break down so rapidly after plasmolysis begins.

During the season of 1931-32 tests were made at the Mississippi Agricultural Experiment Station by stripping the leaves from Johnson grass and alfalfa and then curing alongside whole plants with leaves attached. Then at hourly intervals weighings were made to determine the amount of moisture lost. The leaves and stems of the stripped plants were weighed together and then at the end of the test each sample was oven dried so that the amount of moisture lost for the various intervals could be expressed in per cent. During the two seasons, thirteen tests were made with alfalfa and ten with Johnson grass. The results of these experiments were formulated into curves by the system of multiple correlation as shown in Figs 1 and 2.

Results of Curing with Leaves Attached and Removed. Fig 1 shows that for the first 10 h the alfalfa plants with leaves attached lost 35 per cent moisture, whereas with the leaves removed they lost only 30 per cent. During the night up to the 21st hour after cut, both lost the same amount—9.5 per cent moisture in each case. For the next 6 h the whole plants lost 6 per cent, and at this point the curves for the two coincide. For the next 5 h, which terminated the experiments, 32 h after cut, the stripped plants lost 4 per cent, while the whole plants lost only 2 per cent. This indicates that the loss of moisture from the plants for the first 10 h is greatest where the leaves are attached, but after that time the indications are that the drawing power of the leaves has been diminished to such a degree that the rate of moisture loss becomes greatest in the case

[1]Second of a series of articles setting forth the results of two years' research in hay curing at the Mississippi Agricultural Experiment Station. Released for first publication in AGRICULTURAL ENGINEERING. Part I was published in the August 1932 issue of AGRICULTURAL ENGINEERING (Vol 13, No 8). (This article has been subjected to the careful scrutiny of research specialists.)

[2]Agricultural engineer, Mississippi Agricultural Experiment Station. Assoc. Mem. A.S.A.E.

[3]Plant physiologist, assistant in agricultural engineering, Mississippi Agricultural Experiment Station.

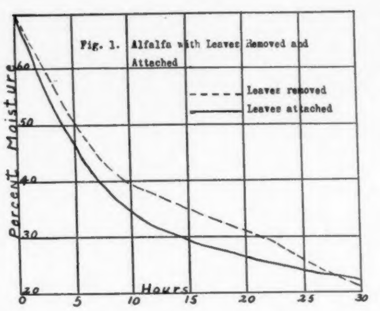
[4]Miller's "Plant Physiology" (first edition), p 313.

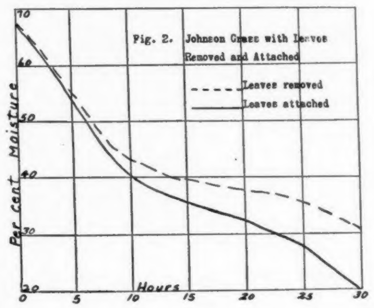
of stripped plants. Therefore, the indications from these results are that the attached leaves exert some influence upon the loss of moisture from the stems of alfalfa plants which is greater even than that caused by wounds and bruises resulting from stripping the leaves.

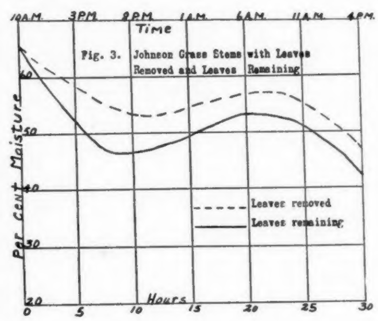
Fig 2 shows the curves of similar tests with Johnson grass with like results except for the fact that the rate of moisture loss at the end of a 30 h period is still in favor of the attached leaves. The continuance of the greater loss of moisture in the Johnson grass with attached leaves for a longer period than was found with alfalfa may be attributed to the continued drawing action of the large midrib in the Johnson grass leaf.

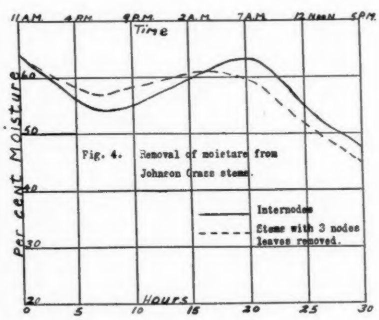
However, contrary to the findings reported in U.S.D.A. Technical Bulletin 1424, two tests run at the Mississippi Agricultural Experiment Station in 1931, at the end of 7 h after cutting, the leaves of Johnson grass that were removed from the stems as cut contained 21.3 per cent moisture, while the leaves that had been attached contained 39.5 per cent moisture. That is, the attached leaves contained 18.2 per cent more moisture at the end of 7 h than did leaves that had been removed, and some of this moisture was drawn from the stem.

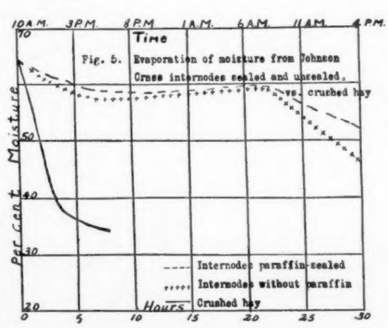
Fig 3 shows the results with Johnson grass stems containing three nodes from which the leaves and sheaths were stripped. The ends were coated with paraffin and allowed to cure in the sun along with similar stems containing three leaves and the cut ends also coated with paraffin. After this treatment there was no outlet for the water except through the leaves and sheaths of the unstripped stems and through the node from which the sheath was cut in the stripped stems. This was true, provided the small amount which comes through the silicious stem wall can be neglected, and it can. There is no greater difference in the moisture content of the stripped and unstripped stems when treated in this way than was exhibited by whole plants with the cut ends exposed as in Fig 2. This would tend to indicate that the leaves afford an outlet which is most favorable for the continuance of capillarity and for a display of cohesive forces within the cell sap of the plant. We would expect this since nature in most cases cares for wounds in the plant kingdom by a rapid drying and consequent formation of an impervious layer, or eventually a callus from the exposed layers of cells so that excessive bleeding and dehydration of the adjoining tissues may be prevented. This secretion and formation of a callus cannot take place in cut plants, but it appears that shrinkage of the tissues and formation of air bubbles within the vessels tend to obstruct the passageway, thereby checking the evaporation of moisture from the











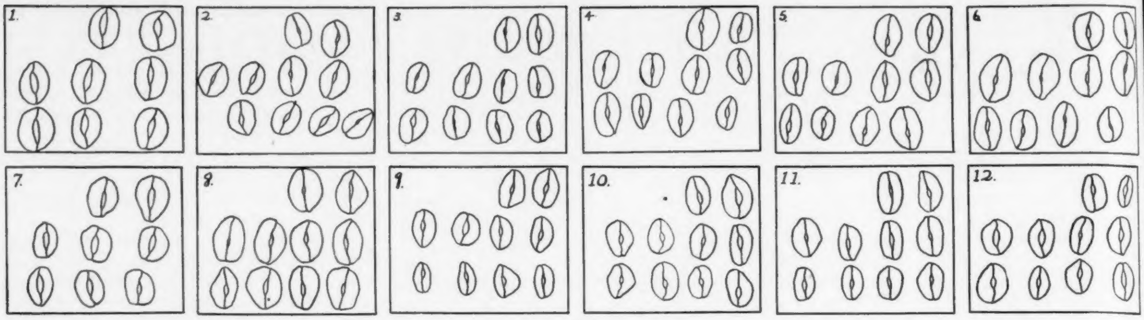
stem. Therefore, it seems that the leaves might possibly have a greater effect upon the removal of the stem moisture than would any mechanical modification of the stem other than a complete mangling as accomplished by crushing.

These curves do not correspond in the rate of moisture loss with those of Fig 2 due to the fact that only the stems are dealt with.

Passage of Moisture Through Nodes of Johnson Grass. To obtain data for the curves in Fig 4, Johnson grass stems containing three nodes were allowed to dry in the sun along with similar stems with the nodes removed by making transverse cuts with a knife. These curves tend to indicate that the moisture is lost more rapidly through the node than through a straight cut across the internode. Therefore, it seems that the fusion of the vascular bundles at the node through which the moisture may be conducted to the leaf affords the most favorable outlet for it and is not sealed so readily as is a cross section of the stem. If this be true we can readily see how the leaf is able to draw water out of a plant of this type, not merely because of a drawing power of its own, but also because it is conveyed to them through these specialized vessels for evaporation.

It is, therefore, clear that the leaves do not have to act as pumps in the removal of water from curing plants. On the other hand, it is necessary only that they remain in a state which favors evaporation of the water conducted to them by the vascular bundles. Then the force of cohesion and capillarity will draw upon the moisture of the stem as that within the stomatal chambers passes off as vapor. It would hardly seem feasible that any of the other factors responsible for the ascent of moisture in living plants should play any great part in similar movements of moisture in cut plants, but it is evident that the osmotic suction of transpiration would exert a pull upon the water in the stem by these forces of capillarity and cohesion provided the leaf is kept in a condition which permits rapid evaporation of its moisture content. The vascular bundles ramify the leaves of plants and there have their terminal points, usually at the base of a stomatal chamber. Thus from these terminal points on through the vessels to the base of the freshly cut stem, there is a continuous stream of water, though small, that may be drawn upon by the forces of cohesion and capillary attraction as the minute particles leave the chamber by evaporation.

The Impervious Nature of the Johnson Grass Stem. The curves in Fig 5 give an explanation of the favorable response of Johnson grass to the process of crushing, since the stem wall is shown to be so nearly



These plates show stomatal behavior on alfalfa plants while curing. Plate 1. As Cut. Plate 2. One hour after cut, from swath. Plate 3. Two hours after cut, from swath. Plate 4. Three hours after cut, from swath. Plate 5. Five hours after cut, from swath. Plate 6. Seven hours after cut, from swath. Plate 7. Fifteen hours after cut from swath. Plate 8. Twenty-six hours after cut, from swath. Plate 9. Three hours after cut, from single windrow raked as cut. Plate 10. Three hours after cut, from single windrow raked 2 h after cut. Plate 11. Three hours after cut, from double windrow raked as cut. Plate 12. Three hours after cut, from double windrow raked 2 h after cut

impervious in nature. The internodes of stems were allowed to cure in the sun with the cut end sealed with paraffin in one case and untreated in another, to get the actual amount of water that passed through the wall of the stem. After 10 h there was a loss of only 7 per cent moisture in the internodes with the ends paraffin-sealed, which results give a fairly definite index to the impervious nature of the cutinized and silicated stem wall.

The curve for the crushed hay was constructed from data taken at another time, but the correlation of atmospheric conditions was made so that they would all be on a comparative basis. The splitting of the stems by mechanical means will expose the inner tissues in which are embedded the conducting vessels with the water, and thus favor rapid evaporation as evidenced by crushing the hay. The crushing not only splits the stems and exposes the vascular bundles, but it also ruptures many of the vessels contained therein, leaving the water free for evaporation without the necessity of passing radially through the cylinder walls. Thus in a monocotyledonous type of plant where this structure is found, it would be only logical to expect a rapid increase in the speed of curing following crushing. Therefore, it may be this morphological difference of the two plants that causes the marked variation in response to crushing exhibited here by Johnson grass and alfalfa, as shown in our first article.

Counts in Number of Stomata. An average of 150 counts of the number of stomata on the alfalfa leaf per unit area gave 95,000 per square inch on the lower surface and 139,000 per square inch on the upper surface. Miller reported, under Kansas conditions, 89,000 and 109,000, respectively, for the lower and upper surfaces. This shows under Mississippi conditions the existence of more stomata per unit area than Miller reported in Kansas, the difference being 6,000 and 30,000 per square inch for the lower and upper surfaces, respectively. This variation may be due to varietal differences or to climatic conditions, or to a combination of both.

Study of Stomatal Behavior in Alfalfa. For a study of stomatal action on the alfalfa plant under the different conditions or methods of field curing, several leaves were picked from representative plants in the various positions at intervals of 15 min during the first hour after cutting; 1 h for the following 10 h, or until nightfall; and 2 h during the night up to 26 h after cutting. As the leaves were selected from the different positions, they were plunged immediately in formalacetic-alcohol fixative and preserved for study. To make the microscopic examination the epidermis was stripped from the leaf, care being taken to keep it wet with the fixative as drying would cause distortion. A wet mount was made of the epidermis and the stomata drawn with the aid of a Spencer Camera-Lucida, using a magnification of 850.

The accompanying plates showing the results of this study contain the stomata drawn without the intervening epidermal cells, since we were interested only in the effect of the size of stomatal pores on the rate of transpiration. Plates 1 to 8 show the rate of closure to be gradual for the first three hours following cutting after which there is no appreciable closure displayed.

During the night, however, there was an indication of a slight reopening of the stomata as dew was absorbed (Plate 7). Samples taken the second day, 26 h after cutting, displayed a closure which was no more complete (Plate 8) than was true for the third hour (Plate 4).

As seen by Plates 9 to 12, the stomata seemed to stay open longer in the windrows than in the swath. This is in accordance with the greater and more rapid rate of moisture loss in the windrows than in the swath (Part I). Plates 10 and 12 seem to indicate that, when hay in the swath is either double or single windrowed 2 h after cut, there is a slight reopening of the stomata during the first hour in the windrow. By comparing Plates 3 and 12, they are seen to be open more after 3 h than they were in the swath 2 h after cut (the time the windrow was raked). Comparison of Plates 11 and 12 shows the stomata to be open more in the double windrow raked 2 h after cut than in the one raked as cut, and comparison of Plates 3 and 10, and 9 and 10, shows a similar behavior in the case of the single windrow.

The tentative indications of an opening of the stomata in this way are in perfect harmony with the exhibited moisture loss. Since there are data from only two years' experiments in support of this factor, we can merely say that the tentative indications are in that direction awaiting further proof for substantiation. This work as stated before is only a part of the progress report and will be checked further in the future.

SUMMARY

1. Leaves of plants are natural agencies for the disposal of plant moisture.
2. Data indicate that the leaves of plants aid in the removal of moisture from the stems while curing.
3. The physiological behavior of stomata may be an explanation of the rates of moisture loss from curing plants under different methods of field handling.
4. The nearly impervious stem wall of Johnson grass seems to allow very little radial evaporation of moisture except through the node.
5. The type of stem possessed by monocotyledons seems to respond more favorably to the process of crushing.
6. The stomata on alfalfa leaves remain open longer when the hay is windrowed than when allowed to stay in the swath.

(AUTHORS' NOTE: The authors wish to acknowledge the valuable suggestions and cooperation of Dr. J. C. McKee, head of the botany department, Mississippi State College.)

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

Steel in the Construction of Farm Machinery, Especially Grain Cleaners and Wagons [trans. title], K. Kermann (Fortschr. Landw., 7 (1932), No 16, pp 409-413, figs 6).—A brief summary of information from various sources is given on the use of steel parts in German agricultural machinery, especially grain cleaners and wagons.

A Device for Use in Determining the Moisture Content of Drying Forages, E. R. Henson (Jour. Amer. Soc. Agron., 24 (1932), No 8, pp 637-641, figs 2).—Weighing devices developed for use at the Iowa Experiment Station in connection with studies on methods of curing and storing hay is described. The first device enabled the operator to arrive at the moisture content by weighing the same rather large amounts of hay at desired intervals without changing their normal exposure. The moisture content of the hay was determined by calculating the loss in weight from a known moisture content at the time of cutting. This device made it possible to arrive at a satisfactorily accurate approximation of the moisture content of the hay at any time during the curing process.

The device used for most of the work was a rack or frame 10 ft long and with teeth long enough to slide under and lift two mower swaths of hay at a time. The teeth were of fir 1.25 in square at the base and tapering somewhat toward the outer end and were spaced 8 in apart and bolted solidly to a 2-by-2-in piece at the base making a huge comb-like frame. In lifting the rack and hay, a 1-by-5-in board 10 ft long was placed under the outer end of the teeth after the rack had been slid under the hay. The two outside teeth had holes in them near the end, and these were slipped over two studs in the ends of the 1-by-5-in piece.

A second weighing device of the same general type was constructed on a smaller scale so that one man might operate and record the weights. It has a rigid frame and rigid teeth 5 ft long. This device is lifted by means of a strap iron bar connected solidly with the back piece of the frame and bent over the load with suitable notches in the lower side to allow for the adjustment of the scale to balance the load. A two-legged rest and a lever across the top with the scales on one end enable one man to lift the rack and read the weight on the scale. This device will weigh a 5-ft section of swath or windrow. Ordinary milk scales may be used for the weighing.

The use of these weighing devices involves either an actual moisture determination at the time the hay is cut or an estimate based on previous determination. The usual procedure adopted for these studies was to determine the moisture content of representative samples of the hay to be harvested for several days in sequence, prior to the day of cutting.

Test data indicate that the weighing device gives a more uniform picture of the condition of the hay than is secured from shrinkage samples. It would appear difficult to sample half-dried hay in the windrow with accuracy. Swath-cured hay seems to cure out more evenly, and successive shrinkage samples do not appear so erratic. Green hay may be sampled rather accurately by the use of shrinkage samples. Half-dried or windrow-cured hay is difficult to sample accurately, as shown by the extreme variations toward the latter part of the test.

The Strength and Related Properties of Redwood, R. F. Luxford and L. J. Markwardt (U. S. Dept. Agr., Tech. Bul. 305 (1932), pp 48, pls 6, figs 21).—Studies conducted by the U.S.D.A. Forest Products Laboratory in cooperation with the University of Wisconsin are reported the purpose of which was to obtain information on the physical and mechanical properties of redwood. The studies included a specific gravity survey and the determination of strength and related properties.

It was found that the redwood studied was higher in such properties as bending strength, crushing strength, and hardness than would be expected from its specific gravity, while in shock resistance it was usually somewhat lower. Redwood in the form of small specimens increased in strength in drying, although the relative increase was less than for most species. A few properties, particularly those indicative of shock-resisting ability, frequently showed a decrease due to drying. The virgin-growth redwood from Mendocino County, Calif., was somewhat stronger than that from Humboldt County, Calif., but the differences in most strength properties were not so great as would be expected from the differences in weight. The strongest virgin-growth redwood, all properties considered, came from just above the butt log.

The moisture in the heartwood of the virgin-growth redwood studied varied from an average of about 140 to 175 per cent at the stump of individual trees to about 60 per cent at mid height, beyond which point it remained almost uniform throughout the rest of the tree. The moisture in the sapwood averaged over 200 per cent throughout the entire height of the tree.

The extractives in the wood affected the strength of the redwood studied, increasing such properties as bending strength and compressive strength, while shock resistance under some conditions was actually decreased.

The shrinkage across the grain of the heartwood of the redwood studied was relatively low. The low shrinkage appeared to be due primarily to the extractives in the heartwood, as the sapwood, which had a lower extractive content, was considerably higher in shrinkage. Occasional pieces of redwood, like those of other softwood species, contained compression wood in varying degrees. Compression wood has a much higher endwise shrinkage than normal wood and is also deficient in strength for its weight, and therefore boards containing much of it should be discarded for most lumber uses.

An appendix contains detailed data from the specific gravity survey, detailed data on strength and associated properties of redwood, and an explanation of terms and methods employed. A list of 14 references to literature bearing on the subject is included.

[Irrigation and Drainage Investigations at the Utah Station] (Utah Sta. Bul. 235 (1932), pp 59, 71-74, fig 1).—The progress results are presented of studies on underground water supplies for irrigation, factors which influence the reclamation of waterlogged and alkali land, the relationship of stream discharge to precipitation with special reference to forecasting the supply of water for irrigation from seasonal surveys of snow cover on mountain watersheds, and factors influencing the financial condition of certain Utah irrigation and drainage projects.

Public Roads, [September, 1932] (U. S. Dept. Agr., Public Roads, 13 (1932), No 7, pp 105-120 + [2], figs 35).—This number of this periodical contains the current status of federal-aid road construction as of August 31, 1932, and the following articles: Static Load and Impact Tests of Lightweight Bridge Floor Slabs, by L. W. Teller and G. W. Davis (pp 105-120); and Bituminous Concrete on Connecticut Avenue Experimental Road (p 120).

An Inexpensive Machine for Filling the Trench Silo, E. G. Diseker (Alabama Sta. Circ. 61 (1932), pp 7, figs 3).—A small power feed cutter without blower is described and illustrated, and test data are reported. The latter indicate that the cutter has sufficient capacity for filling a trench silo and that a 4-hp gasoline engine furnished ample power to operate the machine at its maximum capacity of 40 tons of silage per day. The cutter is said to cost about $30. Suggestions for its operation and care are included.

The Smokiness of Oil-Burning Orchard Heaters, W. R. Schoonover and F. A. Brooks (California Sta. Bul. 536 (1932), pp 67, figs 42).—The results of tests to determine the smokiness of oil-burning orchard heaters are reported. These showed that different heaters vary greatly in smokiness and that it is possible to burn ordinary grades of fuel oil in simple, inexpensive heaters without producing visible amounts of smoke at normal burning rates. Furthermore the smokiness of many types of heaters can be reduced by proper regulation and frequent cleaning. It was also found that the composition of fuel oils available commercially has no consistent influence on the smokiness of different heaters. Laboratory tests run at summer temperatures were found to be a reliable indication of the relative smokiness of heaters as operated in the field during the winter.

Description of the experimental apparatus and methods and of the method developed for correlating light interception and weight of smoke particles are appended.

Irrigation Principles and Practices, O. W. Israelsen (New York: John Wiley & Sons; London: Chapman & Hall, 1932, pp XIV + 422, pls 8, figs 174).—This book is intended primarily to meet the needs of those who seek information concerning the aspects of irrigation, which are not considered in works on irrigation engineering. Among other things it deals with sources and conveyance of irrigation water, measurement of irrigation water, pumping water for irrigation, irrigation methods, farm irrigation implements and structures, some properties of soils, basic soil and water relations, storage of water in soils, the movement of water in soils, irrigation and alkali, transpiration and evaporation, time of irrigation, consumptive use of water in irrigation, relation of crop yield to water consumed, social and administrative aspects of irrigation, amounts of water used in irrigation, efficiency and economy in irrigation, irrigation of cereals, irrigation of alfalfa, irrigation of sugar beets and potatoes, irrigation of orchards, irrigation in humid climates, and the problems of irrigation.

A list of references is given at the end of each chapter, and a number of problems and questions are presented in the appendix.

Refrigeration, J. A. Moyer and R. U. Fittz (New York and London: McGraw-Hill Book Co., 1932, 2. ed., pp X + 538, figs 294).—This is the second revised edition of this work.

Principles of Refrigeration, W. R. Motz (Chicago: Nickerson & Collins Co., 1929, 2. ed., pp XI + 707, figs 163).—This is the second revised edition of this book.

Principles of Refrigeration, W. H. Motz (Chicago: Nickerson & Collins Co., 1932, 3. ed., pp XI + 1019, figs 322).—This is the third revised edition of this book, in which much of the original subject matter has been rewritten and rearranged.

1932 Supplement to Book of A.S.T.M. Standards (Philadelphia: Amer. Soc. Testing Materials, 1932, pp 102, figs 15).—This pamphlet comprises the second supplement to the 1930 Book of A.S.T.M. Standards, and contains seven standards adopted or revised on September 1, 1932. These include among others standard methods of sampling and testing Portland cement and of testing for distillation of natural gasoline.

The Travel of Pollution Underground, A. F. Dappert (Amer. Jour. Pub. Health, 22 (1932), No 9, pp 989-994).—This is a condensed version of a paper presented at a meeting of the New York State Sewage Works Association at Buffalo, N. Y., in June, 1932. It summarizes different studies on the distance of travel of bacterial and chemical pollution from sewage through soils, bringing out that chemical pollution can be carried for a long distance through fine sand even when the rate of ground water flow is fairly slow.

Bacterial contamination has been found to travel as far as 232 ft through fine sand but apparently is removed in a relatively short distance. However, chemical pollution as indicated by free ammonia tests has been found to travel through fine sand for distances considerably in excess of 1,400 ft.

Feed Grinding with Electric Motors, 10 Hp and Larger (Chicago: Com. Relat. Elect. Agr., [1932], pp 4, figs 4).—Data on the adaptation of electric motors of 10 hp and larger sizes to feed grinding are presented.

Feed Grinding with Electric Motors, 3 Hp to 7½ Hp (Chicago: Com. Relat. Elect. Agr., [1932], pp 4, figs 4).—Data are presented showing how electric motors from 3 to 7.5 hp may be adapted to feed grinding.

Forage Grinding and Chopping with Electric Motors (Chicago: Com. Relat. Elect. Agr., [1932], pp 4, figs 3).—General information is given on the subject based on the results of tests at different experiment stations.

Feed Grinding with Electric Motors, 2 Hp and Smaller (Chicago: Com. Relat. Elect. Agr., [1932], pp 4, figs 5).—Data are presented on the adaptation of small electric motors of 2 hp or less to feed grinding.

Public Roads, [October, 1932] (U. S. Dept. Agr., Public Roads, 13 (1932), No 8, pp 121-136 + [2], figs 16).—This number of this periodical contains the current status of federal-aid road construction as of September 30, 1932, and the following articles: Research on the Atterberg Limits of Soils, by A. Casagrande (pp 121-130, 136); The New Hampshire Traffic Survey, by L. E. Peabody (pp 131-136); and Cement Concrete Gives Good Service on Connecticut Avenue Experimental Road (p 136).

The Poultry House Floor, R. H. Waite (Maryland Sta. Bul. 334 (1932), pp 63-78, figs 11).—In Part 1 of this bulletin experiments are reported in which common straw was found to be a satisfactory material for insulating a cement poultry house floor against rise of capillary moisture. A moisture test was made in which 25 gal of water was poured daily through a small hole in the straw-insulated floor for 16 consecutive days in weather of late winter. There were no signs of dampness on the surface of the floor at any time. At the end of approximately three years it was found that the straw had rotted out leaving a dead air space underneath the cement. A straw-insulated floor was found to dry very quickly, which is of special advantage in late fall construction. Directions for construction and amount of material required are given.

In Part 2 experiments are described which showed that a poultry house floor built of cement is warmer in cold weather and cooler in warm weather than a wood floor, due to the equalizing effect of the soil underneath. A wood floor maintains approximately the same temperature as the outside air. A cement floor is much more comfortable to the birds in extreme heat waves and is likely to have a favorable effect on mortality due to heat. The possibilities of bettering temperature conditions in a poultry house by building it partly under ground, where conditions are favorable for this construction, are pointed out.

Moisture Content of Wood in Dwellings, E. C. Peck (U. S. Dept. Agr. Circ. 239 (1932), pp 24, pl 1, figs 17).—This publication furnishes definite recommendations for the prevention of moisture changes in wood, which are based on a study by the Forest Products Laboratory, in cooperation with the National Lumber Manufacturers' Association, the Western Pine Manufacturers' Association, and the Southern Forest Experiment Station, of the moisture content of wood in service in dwelling houses in various regions throughout the United States.

The data indicate that for any individual piece of interior-finishing woodwork to be used in dwellings in most parts of the United States the moisture content at the time of installation should be between 5 and 10 per cent of the weight of the oven-dry wood. In the damp southern coastal regions where the humidity is high it should be between 8 and 13 per cent, and for the dry southwestern region where the humidity is low it should be between 4 and 9 per cent. For sheathing, framing, siding, and exterior trim to be used in dwellings in most parts of the United States the moisture content of any individual piece at the time of installation should be between 9 and 14 per cent of the weight of the oven-dry wood, and in the dry southwestern regions between 7 and 12 per cent.

In so far as is practicable wood should be protected against extreme changes in atmospheric humidity or direct contact with water during and after manufacture.

Soil Erosion in California: Its Prevention and Control, W. W. Weir (California Sta. Bul. 538 (1932), pp. 45, figs. 40). This well-illustrated bulletin describes prevailing conditions of soil erosion in California and presents practical information on control with particular reference to terracing, contour cultivation, strip cropping, underdrainage, and the use of soil-saving dams.

Agricultural Engineering Investigations at the Mississippi Station, T. N. Jones (Mississippi Sta. Rpt., 1932, pp. 7-10). The progress results are reported of studies on the physiology and mechanics of weed control on cotton soils, hay curing by natural means, and the crushing of Alfalfa and Johnson grass in connection with curing.

Geology and Ground-Water Resources of the Dalles Region, Oregon, A. M. Piper (U. S. Geol. Survey, Water-Supply Paper 659-B (1932), pp IV + 107-180, pls 9, figs 3). This report is based upon an investigation conducted in cooperation with the Oregon Experiment Station to determine the feasibility of pumping water from wells for irrigating orchard and produce tracts in the vicinity of the Dalles, Oregon.

The data indicate that there are two possible sources of ground water for irrigating the existing orchards, the upper and lower water-bearing zones of the Yakima basalt. The existing truck gardens can be irrigated from wells of moderate capacity in the alluvium or from wells of larger capacity drawing from the lower water-bearing zone of the basalt. The Dalles formation generally has so small a water-yielding capacity that it is not a feasible source of water for irrigation. The water in the upper water-bearing zone of the basalt has a much higher head than that in the deeper zone and can be raised to a large part of the existing orchards by lifts between 150 and 450 ft.

The Cracking of Palm Oil, J. C. Morrell, G. Egloff, and W. F. Faragher (Jour. Soc. Chem. Indus., Trans., 51, (1932), No 18, pp 133T, 134T). Studies are reported on the possibilities of palm oil as a source of motor fuel. Two grades of palm oil, Niger and Sumatra, were used as cracking stock. The Niger palm oil was reddish-brown and contained approximately 50 per cent of free fatty acids. The Sumatra oil was light orange in color, showing about 6 per cent of free fatty acids.

A yield of 62 per cent of motor fuel was produced from Sumatra palm oil by cracking. At the same time 11.6 per cent of Diesel oil was produced. A yield of 71 per cent of motor fuel was formed from Niger palm oil by cracking, together with 9.5 per cent of Diesel oil. It was found that the cracked distillates from palm oils can be refined to give motor fuel suitable for the operation of internal combustion engines.

Palm oils consisting principally of glycerides of the fatty acids break down under pressure distillation into low-boiling hydrocarbons with the formation of water, aldehydes, fatty acids, and glycerides of lower molecular weight, gas, and coke. The free fatty acids present in palm oil are decomposed similarly. The hydrocarbons resulting from the pyrolysis of palm oil belong to the four major groups, namely, olefin, aromatic, naphthene, and paraffin hydrocarbons.

Some Observations on Physical Methods for the Examination of Paint, J. A. F. Wilkinson (Jour. Oil and Colour Chem. Assoc., 15 (1932), No 148, pp 259-275, figs 2). The urgent need for accurate and reliable methods for the physical examination of paints is pointed out, especially in connection with the preparation of specifications for paints containing vehicles other than linseed oil. Possible methods of preparing films of the required thickness which have been dried under standard conditions, and of measuring various physical properties are discussed, flexibility and hardness being considered to be two of the most important.

Progress in Rural and Farm Electrification for the 10 Year Period 1921-1931. (N.E.L.A. [Natl. Elect. Light Assoc.] Pub. 237 (1932), pp II+13, figs 4). This report indicates that the number of farm consumers of electricity in the United States increased from 177,561 during 1924 to 698,786 at the end of 1931, and that 13.5 per cent of the total number of farms in the United States had electric service as of April, 1930. Of this number 4 per cent had individual plants, and 9.5 per cent were

being served by electric light and power companies. At the mid-year 1932 there were approximately 1,000,000 farms with electric service from power companies and individual plants and 1,000,000 other rural customers outside of incorporated cities and villages.

The Drying of Wheat, E. Stansfield and W. H. Cook (Canada Natl. Research Council Rept. 25 (1932), pp 104, pls 4, figs 33). This reports a continuation and extension of studies which were the subject of a previous report.

In 1929 a new experimental drier was constructed in order to increase the range of operation and the scope of the experiments. The results obtained with this drier form the main body of this report. Nine main series of experiments were made, the most extensive being a study of the continuous discharge and batch methods of drying. Some observations were made on commercial driers at Vancouver in 1930, and these are reported in Appendix A. A review of the literature on bin drying is given in Appendix B. Other experiments, conducted to aid in interpreting the results, are included in the report and in the additional appendixes.

The temperature of the hot air used for drying is of prime importance in commercial driers, and it has been found that the measurement of this temperature may be seriously affected by radiation. The extent of the resulting error depends on the location and type of the measuring instrument. It is recommended that the sensitive part (i. e., thermometer bulb) of such instrument be suitably screened to prevent this error. In measuring the temperature of the grain in the heater section, it has been found that at any point in the grain column the surface temperature of the grain is in moderately close agreement with that indicated there by a thermocouple. In other words the surface temperature of the grain is about the same as that of the air flowing at that point. A suitable location for measuring the average temperature of the grain is near the bottom of the heater section at a point where the air flow is at a minimum.

It has been found that the efficiency of drying increases as the temperature of the hot air is increased, but high temperatures are prohibited by the risk of injury to baking quality. The efficiency, on the contrary, decreases when the hot air flow is increased, because the air passes through the drier more rapidly and has less time to give up its heat to the grain. The drier the wheat the more difficult it is to remove a unit amount of water. The average efficiency is consequently less for grain dried from a low initial moisture than for grain dried from a high initial moisture to the same final moisture content.

The rate of drying increases with the heat content of the air supplied per unit of time. Raising either the hot air temperature or the hot air flow will, therefore, dry the grain more rapidly. Fast drying is deprecated, however, since it causes injury to baking quality.

Drying to a low final moisture content tends to give high wheat temperatures, since the cooling effect of evaporation is reduced as the grain becomes drier. Rapid drying also gives high wheat temperatures. There is apparently little relation between the initial moisture content and the temperature attained by the wheat. These results show that overdrying and rapid drying are the main causes of high grain temperatures in the heater section.

The milling results show that there is no significant difference in the yield of flour under the tested conditions of drying, hence the milling quality was unaffected by drying. The baking quality, on the other hand, showed injury under certain conditions.

The condition upon which injury to baking quality is most dependent is the temperature of the hot air. The results obtained show that 180 deg F is the maximum safe temperature for the drying air. Above this limit the extent of injury increases with the temperature and rate of drying. Even at 180 deg damage may occur if high air flows are used. Injury from rapid drying is unlikely if the wheat remains in the heater section not less than 10 min for each 1 per cent loss in weight when the wheat is dried over a moisture range of from 19 to 14 per cent. The limiting rate varies with the drying range. High wheat temperatures, though to a less extent than hot air temperatures, are related to injury. There is probability of damage by continuous drying if the temperature of the wheat leaving the heater section exceeds 110 deg. The extent of injury is apparently not dependent on the initial moisture content of the wheat. Grain of high or low moisture content can be dried with equal safety provided an air temperature of 180 deg is not exceeded and the rate of drying is not excessive.

Experiments in which wheat was dried to low moisture contents showed that this involved considerable extra time, gave a low drying efficiency, and caused high wheat temperatures. The results indicate that if the air temperature of 180 deg is not exceeded, little damage will be caused by such slight overdrying as is beyond the control of the operator.

It was found that drying in cold weather is no more detrimental to baking quality than drying under ordinary conditions. Drying with humid air reduced the drying efficiency and gave slightly higher wheat temperatures, but did not affect the baking quality significantly.

Batch drying was found to be less efficient and consequently slower than the continuous method, and the maximum wheat temperature observed in the heater section was higher than in runs by the continuous method. In batch drying, unlike continuous drying, the temperature of the wheat is much more dependent on the air temperature than on the rate of drying. The risk of local overheating can therefore be reduced by the use of low air temperatures. The results of the baking tests show that the limiting permissible conditions, with respect to air temperature and rate of drying, for continuous runs are also permissible for batch drying.

Tests of local overheating due to metal walls in commercial driers showed less local overheating, a greater drying efficiency, and somewhat less injury to baking quality with the metal than with the cardboard partitions. This shows that good heat conductors tend to distribute the heat more uniformly than insulating materials. Contact with hot metallic surfaces therefore appears not to be a factor in causing injury in commercial drying.

Gasoline Automobiles. J. A. Moyer (New York and London: McGraw-Hill Book Co., 1932. 4 ed, pp IX+509, figs 467). This is the fourth revised edition of this book. It contains chapters on automobile types and parts; automobile engines; gasoline and substitutes; gasoline carburetors; automobile ignition, magnetos and ignition testing; electric starters; clutches, transmissions, and differentials; lubrication and cooling systems; and automobile troubles and noises.

The Practical Problems of Corrosion. Part VII, Some Tests of Protective Painting: Interim report, S. C. Britton and U. R. Evans (Jour. Soc. Chem. Indus., Trans., 51 (1932), No. 28, pp 211T-218T.) The progress results of studies on paint as a protective coating are briefly reported. Wrought iron and copper steel, properly painted, appear to give better service than ordinary steel, owing to the more adherent character of the rust. Electrolytic iron develops rust more slowly than steel at first, but after 2½ years there is little to choose. A single coat of red lead in the Cambridge, England, atmosphere gives almost complete protection to good steel for a period long enough to produce perforation of the specimen (0.32 mm thick) where it is unpainted.

Salt, moisture, or old rust shut in below a paint coat cause it to fall prematurely. Mill scale varies greatly in its behavior. A typical scale may seem to help an unsatisfactory paint to protect from frontal attack, but below a good paint (which by itself should prevent frontal attack) scale aids the undermining type of attack and is particularly unfavorable on its effect when the time for repainting arrives. A scale broken locally is far more objectionable than a complete scale, and in such cases rapid peeling of paint and scale together often occurs.

Metallic zinc paints can give some protection even at an uncoated gap in the coat under atmospheric exposure, while red lead gives some protection at a scratch line under immersed conditions. The amount of oil and thinner does not greatly affect the value of red lead paints, provided that the paint is not so thin as to produce clear channels. Iron oxide paints become steadily less protective as they become thinner. The effective life of the paint decreases with the drier content if it is applied in dry weather, but increases with the drier content if the painting is done in wet weather.

The compositions of the metals and paints used are shown in appendixes.

Terracing to Control Erosion, J. S. Glass (Kans. State Col. Ext. Bul. 70 (1932), pp 41, figs 59). A large amount of practical information is given in this well-illustrated publication on terracing and gully control. It appears that the broad base terrace having a slight grade is best adapted to Kansas conditions.

Inexpensive Silos for Kansas, J. W. Linn, W. G. Ward, and D. M. Seath, (Kans. State Col. Ext. Circ. 94 (1932), pp 14, figs 17). This bulletin deals principally with the planning and construction of the trench silo and gives some practical information on pit, bundle, and crib silos.

Book Review

Farm and Village Housing" is the title of a contribution from the Committee of Farm and Village Housing of the President's Conference on Home Building and Home Ownership appointed by President Hoover to consider the problems of rural housing, and was prepared for the Committee by Bruce L. Melvin, Washington, D. C. The material presented is divided into six main parts, including farm and village housing conditions, design and construction, farmstead planning and beautification and painting, economic and financial aspects, some special phases of problems of farm and village housing, and educational aspects. Under these headings are included a study of farm and village houses in the United States, housing conditions and problems in part-time farming, a brief history of rural architecture in the United States, suggested standards for farm houses, for the farm house, planning the farm house, practical suggestions on frame house construction, house for the growing income, farmstead planning and beautification, problems and the methods of financing buildings and improvements, relation of taxation to farm and village housing, insurance on farm and village dwellings, and a program of needed research and education on farm and village housing.

AGRICULTURAL ENGINEERING

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Raymond Olney, Editor

R. A. Palmer, Associate Editor

The Materials of Agricultural Engineering

ALTHOUGH the American Society of Agricultural Engineers celebrated its quarter-centennial two years ago, agricultural engineering is yet a young profession. It is natural that for a quarter century or so after formal organization the subject matter of the profession should consist mainly of design, and of mutual adaptation between design and demand by the methods and conditions of agriculture. Developments during the two years of our second quarter-century indicate that we are reaching that degree of maturity in which the materials take equal rank with design and its adaptations.

This is beginning to crystallize into plans for giving special attention to materials for agricultural engineering uses, with initial emphasis on the materials of farm machinery. Let it be said in advance that, so far as consistent with technical requirements, the experience and standards of other branches of engineering should be adopted. Originality is a dubious virtue if it conflicts with the economies of established production and distribution.

In the realm of farm machinery and tillage tools there are more reasons than mere maturity why emphasis on materials is now in order. Research in soil dynamics (and again we think of Professor Nichols' decade of basic studies) seems to be reaching the point where reactions between soils and metals will be quantitatively described. The mathematical theory of moldboard plow design has already been worked out so that, in theory at least, any desired speed can be designed into the plow. Assuming that this principle will be extended to other tillage devices we are ready for a new era of field speeds.

This has come along just when the pneumatic tractor tire is bringing its promise of sustained efficiency at materially increased tractor speeds. It can hardly fail that higher rubbing velocities and concentration of wear on fewer units will focus attention on the abrasion resistance of all the old and perhaps some new plow metals. Speed implies rapidly increasing dynamic stresses, with corresponding need for stronger structural members, and in many cases with weight reduction to be desired.

Obviously, it is futile to combine lightness with strength to the point where wheel weights must be added to tractors, or in ground-driven machines, or in implements where weight is essential to proper penetration. Nevertheless, we think the time is at hand when "heavy" will no longer be the most compelling word in the implement salesman's vocabulary. It is logical to expect tractor engine power to be applied increasingly by way of the power take-off, with diminished emphasis on dead-weight for tractive purposes. Surely in the drawn and shaft-driven machine lightness combined with strength sufficient for higher speeds will be increasingly a virtue.

Corrosion resistance is another property of farm equipment materials which seems due for attention. It is to be considered not only in connection with the handling of concentrated fertilizers, spray chemicals, etc., but in relation to the mooted question whether farm machines should be housed against the weather, or whether resistance to ravages of the elements should be built into the machine itself.

Perhaps it should be said—and again we speak more particularly of farm machinery—that neither the feature articles published in these pages, nor the formal papers presented at meetings, reflect adequately the interest and activity already built up in materials. We need go back only to the technical division meetings of last November for an example. At an evening round-table session by the tillage group, plowshare materials were discussed with amazing thoroughness and candor by responsible engineers of some three or four of the principal implement manufacturers, by development engineers of three types of advanced metallurgy, by engineers from the colleges and experiment stations where independent research and experience studies have been done, as well as by other interested persons not readily classified.

Terracing for Idle Acres

BEFORE the land-leasing plan of so-called surplus control is tossed into the limbo of things forgotten, or is revived and enacted into law, as the veering gusts of congressional opinion may blow, one fact should be impressed on America's political and economic leadership. More important than price control or production control is erosion control.

The soil is America's one permanent asset. It may be kept permanently productive, or by erosion be permanently lost. Appalling as soil loss may be under normal cropping, it is likely to be far worse under what could correctly be called a fallow condition. If we are to have a planned national economy, and reduction of tilled acreage is to be part of it, any subsidy on idle land should surely be conditioned on the permanent protection of that land—or other land on the same farm—from eternal destruction by erosion.

Cover crops have their helpful place, of course, but they are merely mitigants of the moment. If the American people are to invest millions or billions in the relief of agriculture, they should demand in return a guarantee of ample and reasonably cheap food for the generations to come. The only basic thing in that is physical preservation of the soil from washing to the sea.

As a class, agricultural engineers are the only men who know both the gravity of the problem and the methods of its solution. A few—too few—members of the Society already have urged on federal officials the wisdom of combining erosion control with any national plan for acreage reduction. They have pointed out that crop vacancy gives chance to get onto the land; that idle acres imply spare man-power and availability of farm machinery which may be put to terracing.

Most of us are experts by virtue of training at public expense; some of us are in public employ. In simple fairness we should use that trained judgment by urging far-sighted measures for the welfare of all America. Erosion control is such a measure.

A.S.A.E. and Related Activities

Two Decades of Farm Machinery Improvement

AN INQUIRY into changes and improvements in farm machines during the past two decades was recently made by three nationally known agricultural engineers. The complete report of this investigation has just been published, and constitutes an exceedingly interesting and instructive presentation of the development in detail of twenty-five representative farm machines. This report is an authoritative treatise dealing with thousands of items in the engineering development and improvement of agricultural implements and machines, and it is of outstanding value to all who are in any way concerned with the design, manufacture, sale, use, or economics of modern farm operating equipment.

The book is entitled "Report of an Inquiry into Changes in Quality Values of Farm Machines Between 1019-14 and 1932," and contains 168 pages, including 64 full-page halftone illustrations showing graphically the changes that have taken place during the last twenty years in twenty-five principal agricultural machines, and in their working parts.

The authors of this notable work are Dr. J. Brownlee Davidson of Iowa State College, Prof. Glen W. McCuen of Ohio State University, and Prof. Ralph U. Blasingame of Pennsylvania College, each of whom is the head of the agricultural engineering department at the institution with which he is associated. The report is published by the American Society of Agricultural Engineers.

Ever since the American Society of Agricultural Engineers was organized in 1907, it has played a part of steadily increasing importance in all branches and fields of agricultural development. One of the most important phases of its work has been in encouraging research in the field of farm operating equipment, in the matter of design, construction, and materials, as well as in the field performance of such machines with reference to their usefulness, durability, and economic value. Professors Davidson, McCuen, and Blasingame have played a conspicuous part in this particular field of their profession.

This comprehensive report forcefully brings home the outstanding fact that, in the final analysis, farmers purchase units of mechanical and economic service rather than mere units of farm machinery. There has been much debate about the extent and nature of the improvements effected in these units during the last twenty years, and about their effect upon agricultural production. Many if not most of the questions that have come up in such discussions are clearly and authoritatively answered in this report.

Not only did the authors examine minutely into the contrasts between completed machines of twenty years ago and those of today, but they also review step by step the progression leading to these changes; and they were not content to deal with the machines under consideration as whole units, but also examined minutely into the evolutionary changes in every part of the machines which they studied. It is interesting to note that the total of pieces studied in the twenty-five machines under consideration, including bolts, rivets, etc., reaches the impressive figure of 13,318 items.

The book is in four parts. Part I sets forth the purpose, scope, and conclusions of the inquiry. Part II presents a chronological record of important changes in each of the twenty-five machines during the past twenty years. Part III exhaustively discusses changes in material used in manufacturing farm machinery. Part IV contains a direct comparison in detail of machines of the 1910-14 and 1932 periods.

The book may be obtained from the publisher, American Society of Agricultural Engineers, Saint Joseph, Michigan, at 50 cents per copy postpaid.

New A.S.A.E. Officers

AS A result of the recent election of officers of the American Society of Agricultural Engineers, the new officers chosen to take office following the 27th annual meeting of the Society at Purdue University this month are as follows: President, Arthur Huntington, public relations engineer, Iowa Electric Light and Power Company; First Vice-President, M. L. Nichols, professor of agricultural engineering and head of the department, Alabama Polytechnic Institute; Second Vice-President, K.J.T. Ekblaw, agricultural engineer, American Zinc Institute; Councilor E. E. Brackett, professor of agricultural engineering and head of the department, University of Nebraska. The Secretary of the Society, Raymond Olney, was reelected Treasurer. The new Council of the Society for the year 1933-34 includes the above named officers together with Theo Brown, Councilor; Hobart Beresford, Councilor; L. J. Fletcher, Senior Past-President; and C. E. Seitz, Retiring President. The newly elected Nominating Committee of the Society consists of E. W. Lehmann, chairman; W. G. Kaiser, and S. P. Lyle.

North Atlantic Section Meeting

ANNOUNCEMENT is made by John R. Haswell, chairman, North Atlantic Section of the American Society of Agricultural Engineers, that the Section will meet at Harrisburg, Pa., at the time of the Pennsylvania Farm Show, which will be held during the week of January 15, 1934. A short business session of the Section will be held some time during the 27th annual meeting of the Society at Purdue University, Lafayette, Indiana, June 21 to 24. The exact time and place of the meeting at Purdue will be announced by Chairman Haswell some time during that week.

Chicago Power Show in June

THE Sixth Midwest Engineering and Power Exposition will be held during the week of June 25, 1933, instead of in February as formerly. The change has been made to give engineers attending "Engineering Week" an opportunity to transact business with a large group of manufacturers who will be showing their products at the power show. Early indications point to a complete utilization of the 85,000 square feet of floor space in the Coliseum with exhibits of machinery, equipment, and supplies portraying the latest advances in the various wide uses of power—from ordinary power-operated tools to large generators, engines, pumps, heating and air-conditioning and many others of like importance.

The educational features of the power show will be sponsored by Armour Institute of Technology, Chicago, and George F. Gebhardt, professor of mechanical engineering, will be in direct charge. It is hoped that these features will be particularly beneficial to every engineer as they will cover the broader aspects of the professional and practical side of power engineering encountered in actual practice.

The strategic location of the Coli-

seum will afford every advantage to the visiting and local engineers to view this most comprehensive exposition. The buildings are only a short distance from all leading hotels and midway between the 12th and 23rd Street entrances to the Century of Progress. Admission will be by invitation issued to the engineers by the exhibitors, and it is presumed over 200,000 invitations will be issued. Because of the large attendance anticipated strict supervision of admission invitations must be maintained.

Oregon Delegation to Purdue

WHAT will doubtless be the largest delegation traveling the longest distance to attend an annual meeting of the American Society of Agricultural Engineers is the group of sixteen or twenty faculty members and students of agricultural engineering from the Oregon State Agricultural College attending the 27th annual meeting of the Society at Purdue University, Lafayette, Indiana, June 21 to 24, according to announcement made by W. J. Gilmore, head of the department of agricultural engineering of that institution, to the A.S.A.E. headquarters recently.

The group will leave Corvallis, Oregon, Wednesday, June 7. On its going trip the delegation will make stops to visit the departments of agricultural engineering at the University of Nebraska and Iowa State College, and also farm equipment factories at Moline and Peoria, Illinois, arriving at Lafayette, Tuesday, June 20. Following the four days at the annual meeting it will then visit farm implement factories at South Bend, Indiana, then spend five days at the Century of Progress Exposition at Chicago, after which the return trip will be made. It is estimated that the round trip will approximate 5500 miles.

Farm Work in 100 Years

THE increasing use of engineering principles in the last 100 years in the operation of farms is shown in models, photographs, plans, drawings, and charts prepared by the U.S.D.A. Bureau of Agricultural Engineering for the Century of Progress Exposition in Chicago.

Three models of a typical farm in the Central West show the evolution in use and care of land, in use of power, and in farm buildings from the primitive stage of 1833, through 1883 when farmers began to apply engineering in their work, to the modern period of today.

In 1833, the homestead with its few small fields was generally an isolated clearing in the forest. Buildings were of logs and farm implements were crude. Power for the most part was the farmer's brawn, supplemented by oxen or horses. During the next 50 years, the farmer enlarged his fields and drained his wet land by ditching. He substituted the faster-stepping mules and horses for oxen, had some machinery in the field, and produced more and better crops.

The application of engineering principles from 1883 to the present has enabled the farmer to make great strides in his business. It has relieved him of much arduous labor and has enabled him to increase production at no greater and often at less cost per unit. The farmer has power machinery, automobile, truck, telephone and radio, and has access to the outside world over hard roads. The modern home has plumbing, heating and lighting systems, labor-saving devices in the kitchen, and mechanical refrigeration. The barn and other buildings are well built and arranged for convenience and efficiency in care of livestock and crops.

Photographs on panels illustrate the research work of the Bureau in soil erosion control, and the changes which have taken place in the kind and amount of power available on farms from 1850 to 1933. A chart shows changes in number of agricultural workers as compared with total population of the country and as compared with all workers gainfully employed.

Plans of various types of farm buildings illustrate the kind of service the Bureau gives in assisting farmers who contemplate construction or use of equipment in farm shelters.

Home Economics Meeting in June

THE twenty-sixth annual meeting of the American Home Economics Association will be held in Milwaukee, Wisconsin, June 26 to 30, 1933, with the Hotel Schroeder as headquarters. The central theme of the discussions will be "Home Economics in a Modern World."

The program will include two public evening sessions addressed by prominent speakers on important phases of education for homemaking, with special reference to the adaptation of home life to present conditions. Opportunity will also be provided for members particularly interested in food, clothing, family economics, family relationships, or the house and its management, to hear these subjects presented by specialists and to join in informal discussions.

Personals of ASAE Members

F. C. Fenton, head of the department of agricultural engineering, Kansas State College, is one of the authors of Technical Bulletin No 33, entitled "The Quality of Wheat as Affected by Farm Storage," recently issued by that institution.

George W. Kable, director, National Rural Electric Project, is author of Report No 7, entitled "Electric Sterilization and Water Heating in the Dairy," just issued by that organization at College Park, Md.

M.A.R. Kelley, agricultural engineer, division of structures, Bureau of Agricultural Engineering, U. S. Department of Agriculture, is author of Farmers' Bulletin No 1701, entitled "Corn Cribs for the Corn Belt," recently issued by the U. S. Department of Agriculture.

E. G. McKibben and **J. B. Davidson,** associate professor of agricultural engineering and professor of agricultural engineering, respectively, Iowa State College, are joint authors of Bulletin No 297, entitled "Wind Electric Plants," just issued by the Iowa Agricultural Experiment Station, Ames.

John E. Nicholas, associate professor of agricultural engineering, Pennsylvania State College, has an article, entitled "The Characteristics of Electric Hot Air Dairy Utensil Sterilizers," in the 9th annual report (1933) of the Pennsylvania Association of Dairy and Milk Inspectors.

New ASAE Members

Elmer F. Clark, research fellow, department of agricultural engineering, Iowa State College, Ames, Iowa.

George M. Suda, blockman, John Deere Plow Company. (Mail) 828 Wisconsin St., Racine, Wis.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the May issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

H. W. Delzell, manager, technical service tire division, B. F. Goodrich Rubber Company, Akron, Ohio.

Walter Godchaux, vice-president in charge of agriculture, Godchaux Sugars, Inc., Box 226, New Orleans, La.

Charles H. Middleton, salesman, Cleveland Tractor Company, Cleveland, Ohio.

Ralph W. Sohl, field engineer, development department, Goodyear Tire & Rubber Company, Akron, Ohio.